POWER

Volume 60 New York, July 29, 1924 No. 5

Useful if Used

A CORRESPONDENT writes that he does not think that the development of the technical staffs of important power plants is keeping pace with the development of instruments for indicating and recording operations in the production of power.

He has returned from a long trip, during which he visited many power plants in many cities in widely separated sections of the country.

Time and again he would see expensive apparatus for measuring the amounts of water and coal and steam and air, the composition and temperature of the flue gases, the quality or temperature of the steam, either out of use altogether or producing records that were valueless except for purposes of comparison.

Perhaps they had been put in by some designer when the plant was built and the man who took over its management did not know how to get the good out of them.

Perhaps some engineer got enthused about the scientific looking instruments and lost his interest through inability to appreciate their indications.

There are many reams of paper used up in making records that are simply hung away on pegs.

A recording instrument can do nothing more than record facts, more or less correctly according to how well it is designed and made and how intelligently it is applied and operated.

The better grades of such apparatus on the market have had lots of brains and money spent on their perfection, and the manufacturers will spend any amount of time and trouble trying to insure for them intelligent use and to teach the men who handle them how to keep them in order and interpret the records that they make.

But they cannot send brains with them, and if the operator has no interest in the results that he is obtaining or no capacity to work them out from the records, it is easy to understand why he feels that buying charts is a waste of money and putting them on and taking them off a nuisance to be abated as soon as the management will stand for it.

F. R. Low

The First World Power Conference

Meets at Wembley, England—Engineers from All Countries Present—Addressed by Prince of Wales—First Session Devoted to Survey of the World's Power Resources

THE First World Power Conference opened June 30 at Wembley in the Palace of Industry of the British Empire Exposition. The underlying purpose of the conference, which was initiated by the British Electrical and Allied Manufacturers Ass'n in cooperation with technical and scientific societies throughout the world, was to consider how the water power and fuel resources of the world may be put to the most advantageous use.

Invitation was extended to representative engineering bodies throughout the world, and so important was the basic subject of the conference that hundreds of delegates were on hand when Lord Derby called the meeting to order and presented the Prince of Wales.

The Prince, as President of the British Empire Exposition, welcomed the delegates. He expressed a hope that the occasion might prove the beginning of a series of conferences, whereby the combined knowledge and judgment of the world might be devoted to the solution of the many difficulties confronting not only science and research, but also economic progress as reflected throughout the entire world.

He pointed out that steam, oil, gas, electricity or some form of power plays a part in practically every industry and that the structure of society itself rests on the effective extraction and utilization of the forces of nature. He stated that inspiration could be found in the fact that over thirty countries were contributing to the maximum of their capacity, gripping at fundamentals in order that the deliberations might look forward to the first enunciations of a policy applied internationally which might contribute very largely to the harmony and progress of the world.

Acknowledgment of the welcome given to them by the Prince of Wales was made by Sir Joseph Cook on behalf of the British Dominions, by Ing. Guido Semenza for the European countries, by Dr. M. Kamo for Japan, M. Guilaume representing France, and O. C. Merrill, representing the United States and South American countries.

Mr. Merrill struck the keynote of the meeting when he stated that the Conference was to discuss power in a new sense, not the power of territorial possession or an economic aggression, but that of mechanical energy and electricity, the greatest tool ever placed in the hands of man. Ancient civilizations were serfdom and slavery, in which man labored unremittingly for years to produce great works; modern civilization was a progressive liberation of mankind by the utilization of the sources of nature through the medium of machinery, reducing human labor, increasing its productivity, adding to the amount and lessening the cost of material things, and at the same time providing people with that leisure by which alone intellectual capacity could be developed.

On Monday evening the Earl of Derby presided at a dinner opening the social activities of the Conference. There were some 750 delegates and members in attendance. Brief addresses were made by M. Arbelot, vice-chairman of the French Committee of the Conference, by F. V. Hansen, the chairman of the Swedish Committee and by Samuel Insull, vice-chairman of the United States Committee. S. Z. de Ferranti proposed the toast of "The Guests," to which response was made by Frank Hodges, Civil Lord of the Admiralty, by J. G. Bellaar Spruijt, of the Netherlands, and by Sir James Allen, High Commissioner for New Zealand.

A most commendable motion was made by the American Committee directing that the Executive Committee inquire into the conditions surrounding Heathfield Hall, the former home of James Watt, which was to have been sold at public auction within a week. The idea is to purchase the property and maintain it intact just as it was when Watt died. By the time the Conference ended nearly one-half the necessary £10,000 had been subscribed. It is possible that the remainder may be solicited in the form of small subscriptions.

EXCERPTS FROM RESOLUTION ADOPTED FOR FUTURE CONFERENCES

It is desirable that the work of the First World Power Conference shall be continued and that consideration shall be given to the advisability of forming a permanent institution at a later stage under such title as may be found best to fit its activities.

Each country participating is invited to create and maintain a permanent National Committee, as far as possible representative of its interests in all aspects of power.

Each National Committee shall be entitled to appoint one delegate to represent it on the International Committee and such appointments shall be made within six months from the date of this memorandum.

The next meeting of the World Power Conference shall be held at a time and place to be determined by the International Committee, subject to the approval of the respective National Committees. So far as practicable future Conferences should be held in different countries.

Survey of the Power Resources of the World

SIR JOHN SNELL in his opening remarks as chairman of the first technical session held on the morning of July 1, stated that the meeting was unique in that it was the first occasion on which the principal authorities on power production in the world had been brought together to discuss questions of international import. He said that neither Britain nor the rest of the world would be content with the partial development of water power, nor would they accept the consumption of three pounds of coal per kilowatt-hour when it was possible to obtain a figure of less than half of that.

Sir Richard Redmayne presented a paper on the "Coal Resources of the World." He pointed out that the world production of coal had more than doubled in the twenty years preceding the Great War and reached

a total of 1,324,000,000 tons in 1913. The production for the year 1922 was slightly below this high level, and in that year the production of the United States was 425,849,000 tons and of Great Britain 249,607,000 tons. It was not likely that the world's supply of coal would last more than from 1,500 to 2,000 years. The coal resources readily available in Europe were being rapidly exhausted, and at the present state of production in Great Britain the life of the coal fields would not exceed 600 years.

At the present time the cost of producing bituminous coal in the United States was only about one-third the cost of mining the same class of coal in Great Britain. A large part, probably one-half, of the coal consumed in the production of power, could be saved by more efficient combustion methods. The chief power resources of Australia were shown in an official report to be in her coal deposits which, in many cases, were in close proximity to the great centers of population, and to this fact must be attributed the hitherto undeveloped state of other sources of powers in the Commonwealth. The estimated coal reserves were 23,000,000,000 tons. The Morwell Power Scheme, in which use would be made of brown coal, was designed to meet the needs of the entire Melbourne area.

Russell Sinclair, of Australia, submitted a résumé of his paper "The Power Houses of the Commonwealth of Australia and Mandated Territory of New Guinea." He pointed out that Australia, with its enormous area, larger than the United States, but with a population of only about six million, had little to contribute to the Conference in the form of energy achievements, but had immense natural resources of coal. Mention was made of the immense undeveloped hydro resources of Tasmania, which was stimated at 700,000 hp., although only about 10 per cent had been developed. Resources in New Guinea were likewise practically untouched. The author's remarks were supplemented by W H. Taylor, general manager of the Electricity Supply for Western Australia, who pointed out that in Western Australia there were but 300,000 people in an area ten times that of Great Britain, although there was a high development of per capita kilowatt-hour consumption. Reference was made to the enormous resources of fuel refuse in the forests, for which economic means for utilization had not yet been developed. There were some experiments with wood gas producers which gave some promise for the future.

Favors Regulated Private Ownership

Prof. A. H. Gibson followed with a review of the water-power problems of Great Britain and Ireland, and seemed inclined to the belief that water-power development fared best under private ownership properly regulated by the State, rather than by State ownership. The many diverse demands of the transportation, fishing and other interests must be considered in connection with water power, and bad competition and legal bickering between such interests has slowed up development in Great Britain. In 1917 there was organized a water-power committee of the Board of Scientific Societies. This was followed in 1918 by the formation of the Board of Trade Committee under Sir John Snell, and since this time recommendations for power development and more economic utilization of more than 250,000 hp. of Great Britain, had been initiated, while the Irish subcommittee have reported some 500,000 hp. available, mostly economically developable, in Ireland. He stated that England's power lay mostly in her small streams with no storage available, and the solution seemed to be small automatic plants connected to steam plants. Ireland has the greatest power possibilities, which have been limited in the past by low per capita consumption in spite of her large available hydro power; 90 per cent of her coal for power is imported. Mention was made of the possibilities of the development of tidal power in Great Britain. A lively interest in it is now being taken by the Government, and it is probable that inquiry will be made in the tidal power resources of the Severn.

Attention was drawn to the vast natural resources of Continental Europe by Dr. G. Semenza,, of Italy. These have not been developed to their ultimate possibilities. While certain countries such as Switzerland have developed most of the commercially feasible sites most of the countries were just realizing the economy of water-power development. Addresses were also made by M. Guilleaume, of France, and Dr. Kamo, Japan, on the resources of these countries.

O. C. Merrill Reviews American Power Resources

O. C. Merrill presented his paper, "National Review of Power Resources of the U. S. A." He referred to the relation of the federal government and of the states to private water-power development, and particularly discussed the functionings of the Federal Power Commission which he administered. The federal government, which controls 85 per cent of the hydro resources, has three interests in their development: (1) Proprietary jurisdiction; (2) a jurisdiction in its interstate problems, and (3) a jurisdiction in its international problems. Fifty-four million horsepower of hydro-electric development was possible in the United States, but it was not known how much was economically developable. He discussed the merits of the Federal Water Power Bill of 1920 and pointed out that since 1920 applications for the development of some 20,000,000 hp. have been made; licenses for the development of 7,500,000 hp. have been issued, of which there are today approximately 2,500,000 hp. under construction.

Coal Supplies Fix Industrial Regions

Dependence on coal and the geographical location of the coal mines fixes the positions of the main industrial activities within the northeastern section of the United States, and over 50 per cent of the bituminous coal production is used in the five States of New York, Pennsylvania, Ohio, Indiana and Illinois. Over three-quarters of the prime-mover capacity employed in central stations, electric railways and industries is found east of the Mississippi River. There are in America 3,200 water-power plants of 75 kw. and more, having a total capacity of 6,778,871 kw., an increase of 15 per cent over the total in 1921. Of this, 81 per cent is used in public-utility plants and the remainder in manufacturing concerns. The potential resources amount to 25,975,000 kw. available 90 per cent of the time and 41,052,000 available for half the year. The estimated coal reserves amount to 1,560,000,000,000 tons, of which 17½ per cent is lignite, 29 per cent sub-bituminous coal, 51 per cent bituminous coal and the remainder semi-bituminous coal. Oil reserves amounting to 10.45 million barrels are also available.

F. A. Gaby, speaking on the "Water Power Resources of Canada, pointed out the large area and small popu-

lation of that Dominion. Hydro power is mostly available in Quebec, Ontario, Manitoba and British Columbia, and the country is peculiarly fortunate in that coal is available in those districts where hydro power is not available. A vast expansion in hydro utilization has occurred during the last few years, but development has been unable to keep up with the demand. As an example of the work done, citation was made of the provincially owned hydro-electric development with 750,000 hp. in operation and 4,000 miles of transmission lines. The speaker's estimate of the available hydro-electric power in Canada was some 18,000,000 hp. continuously available, or 40,000,000 hp. with a 40 per cent load factor, on which latter basis they had been accustomed to figure Canadian statistics.

John W. Lieb, of New York, read abstracts of both his own report on the resources of the Northeastern States and that of Samuel Insull on those of the Central States. He spoke of the superpower centralization and its consequent improvement of load factor, mentioning the necessary standard of voltages, frequencies and practices which have been necessary in interconnecting the great power systems in Pennsylvania, New York and New England.

United States Uses 18,800 Kilowatt-Hours per Square Mile per Year

The per capita kilowatt-hour consumption in these states was given as 624 kw.-hr. as compared with 509 for the whole of the United States. The kilowatt-hours per year per square mile in the Northeast was stated to be 96,620 as compared with 18,800 for the entire country.

In 1922 the total kilowatt-hours supplied by central stations in the Northeastern States was about 15,876,000,000 and the installed plant capacity was about 5,838,000 kw., the annual rate of growth being between 10 and 15 per cent. With the growth of the power market there was shown a steady movement to increased sizes of plants and to make interconnection between otherwise independent systems. While it is estimated that six million horsepower can be developed at Niagara and that there are possibilities of not less than five million horsepower on the St. Lawrence, much of the other water-power resources require large reservoirs to overcome the wide variations in stream flow.

Nearly all the water powers of the Mississippi were of such a character as to require a reserve steam plant of nearly equal rating. In some instances the magnitude of the capital necessary for water-power development made economic working impossible.

The hydro-electric development in the Southeastern Power Zone of the United States was covered by W. S. Lee. It was stated that the interconnection of the several independent power systems was made possible by the fact that all the concerns had already standardized on 60 cycles, with the principal circuits at 100,000 volts. Mention was made of how, during a water shortage in North Carolina, power, by interchange with the several connecting links, was delivered by the Alabama Power Co. The chief requirement in interconnected operation is close co-operation between the load dispatchers. The author was confident that the increased power demands call for the most economical development and utilization of the water-power resources of this section.

E. Perry, of the Dominion of New Zealand, abstracted Laurence Birk's paper on the water-power resources of New Zealand. He brought out an interesting policy which had been adopted in New Zealand. In spite of the low density of population, the State in its control of water power, has taken the stand that the more isolated the user the greater is the need for power. This had resulted in the per capita consumption in New Zealand of some 4 to 5 horsepower against an average of about ½ hp. throughout the world. Subsidiary consideration only has been given to the cost of line extension by the New Zealand Government, while primary consideration had been given to making power available to every citizen of the dominion.

Tuesday Afternoon Session Continues Economic Discussion

At the Tuesday afternoon session Dr. George Otis Smith (U. S. A.) presiding, the discussion covered the power resources of countries other than the British Empire and the United States.

The Austrian representative, Oskar Taussig, feared that the coal reserves of his country would be exhausted within a century. It seems necessary then, to conserve coal by the fullest utilization of the available water power.

The prosperity of Belgium, so it was stated by Emile Wythorck, was based on the large coal deposits, over twenty million tons being mined yearly.

In Czechoslovakia, although there are almost 2,000,000 potential hydro horsepower, only a tenth of this is in use. The lack of coal was an argument in favor of the electrification of the country, so it was stated by Dr. Ivan Zmavc.

In France, as reported by M. Arbelot, the electrification of a number of the railroads is in active process. Power is obtained from hydraulic development in the Alps and in the Pyrenees. The most important development in the near future would be on the Rhone and on the Rhine rivers.

Prof. G. de Marchi, in a report on Italian hydraulic development, gave an analysis of the growth of this phase of engineering in Italy. Long-distance transmission of hydro-electric energy has solved the problem of avoiding coal importation. Recent activities indicate that hydro power will permit the reclamation of much of the now desert Calabria district.

While other nations have depended upon coal to a large extent for power, Switzerland was compelled by lack of this fuel to develop the water sites until at present, so her representatives, J. Buchi and H. Eggenberger, stated, over 60 per cent of the total hydro resources are in use. The progressive use of the water power has decreased coal importation since 1913 by 30 per cent. At present there is an output of over 600,000 horsepower-years, the installed capacity being 1,490,000 horsepower.

Scandinavian Countries Rich in Water Power

Norway and Sweden are particularly favored by a large number of valuable water-power sites. Having no coal beds, the country has been compelled to depend almost exclusively on hydraulic power. I. Kristensen reported that the hydro resources of Norway, most of which are at present commercially undevelopable, total over 12,000,000, of which 1,200,000 hp. is in use.

In Sweden the State has proceeded with the development of many of the sites. Of the 11,600,000 hp. of potential power, 1,400,000 is in use, of which over 25 per cent is state owned. The state exercises no monop-

oly, but wherever it is feasible, co-operates with private capital to develop these sites.

China has ever been a land of mystery, and even its engineers have no exact data as to its coal, oil and water power resources. This point was stressed by T. Shing and W. H. Wong, who estimated that the anthracite coal resources were over three billion tons, while peat, lignite and bituminous coals were found in many of the provinces, making the total resources over twenty billion tons. The lower reaches of all the rivers pass through flat country, precluding any water-power development, but the upper ends of almost all the streams offered some possibilities.

Whatever may be one's opinion of the Russian Soviet Government, it must be conceded that it has embarked upon a notable plan of developing Russia's power resources. While the country has over 400,000,000,000 tons of coal under ground, almost all of this is lignite. In 1920 a state commission was appointed to study maps and means of electrifying the country. It recommended that wherever possible the hydraulic sites should be developed. As pointed out by the Russian representatives, Prof. M. Prigorowsky, Alex. Kogan, Prof. Glouchkow and I. Wichliajew, the industrial portion of Russia is in and about Petrograd and Moscow, where there are no coal beds or water power. In the extreme south are the oil fields and the hydro sites in the Caucasian Mountains, but this being a non-industrial region, no demand exists for power. It is planned to develop the sites and transmit the power to the manufacturing centers in the interior of Russia. While there are immense water-power possibilities in Eastern Siberia, these sites are so remote that no immediate development is to be expected.

The Economic Aspect of Power Resources

THE sessions of Wednesday morning and afternoon dealt with the economic, financial, legal and political aspect of the power situation, and the impression was made that an international policy to expedite power development is now definitely started.

The opinion was expressed that the great fuel resources of many of the principal nations of the world were at present being steadily misused to the detriment of development of essential electric power.

Sir Robert Horne, presiding in the morning, said that the world found itself at present in a most confused position. It is a world crippled by war, which had wiped out the carefully accumulated wealth of the past. The only way to save the world from the war's result is to increase its productiveness, particularly through the great development of power. The world's store of coal is being badly misused, and this is particularly true in Great Britain. If this coal were properly used, Great Britain could have three times as much power as at present.

David Rushmore, of Schenectady, spoke of the changing economic order in the power industry. In the early days, developments were slowed up by a faulty handling of the public by private power interests, resulting in adverse public opinion. He pointed out that power progress should follow public opinion rather than endeavor to anticipate it. It is obvious that capital must have a fair return, for without it further development is impossible. An era of sound power economics in the United States has brought such interesting developments as customer and employee ownership.

C. Kleman, discussing his paper on power policy in Sweden, stated that power conditions in each country determined the policy to be pursued. The system of state management in the power field in Sweden, in competition or in co-operation with municipalities and individuals, has been an advantage to the consumer, and there is now no general controversy concerning the question of state or private ownership.

Sir Philip A. M. Nash submitted a paper on the economics of the world's power. He felt that, as we were only on the threshold of the world's larger power development, we must be very careful in our decisions of today, as small suggestion now may result in either great good or great harm for the future. The great problem is fuel economy. The modern power station requires from 1.78 lb. to 2.28 lb. of coal to generate one kilowatt-hour; the change from 10 lb. of coal a few years ago is a great achievement, but it is not enough. The efficiency of conversion from fuel to power, even in the most modern power stations, is not more than 22 per cent.

Dr. H. J. Van Der Bijl, chairman of the Electricity Supply Commission of South Africa, stated that they have preferred to develop power from coal rather than hydro power in South Africa, as the latter had proved too expensive to develop. Their new policy contemplates vast mine-mouth power houses, so far as availability of condensing water makes it possible. Coal is surprisingly cheap in South Africa at the mine's mouth.

Profits Necessary If Capital Is To Be Obtained

Sir Ernest Harvey, a British banker, presented a paper on the "Effect of Depreciated Currencies and International Financial Conditions on Power Development Within the British Empire." War as a business was carried on without profit by government, and we must now return to the realization of the necessity for profits to secure capital. It was curious, he pointed out, that the present high cost of the fuel required by a power plant had acted as an incentive to create new plants. In the United States money has been diverted from commercial ventures to aid state and municipal extravagance, and power development has been a costly process.

He said one of the great difficulties in the financing of power projects has been in the handling of municipal legislative bodies; that in his experience in the United States and in Canada particularly, the state and governmental regulatory bodies had been quite fair in all their demands. Suitable practical conditions are the primary necessity for proper power development; its greatest handicaps are bad government and misuse of the press.

W. S. Murray, of New York, stated that the economics of the future lay in proper diversity and economy.

H. M. Addinsell made a plea for regulated monopoly as it had been carried out in the United States.

The Wednesday afternoon session was carried on under the presidency of M. Arbelot, of France.

F. R. Low, of New York, brought out that the capacity of the people to do things depends upon the available power and that all the labor of all humanity combined could not perform the work that power does. Labor is more and more appreciating the fact that the more

power available per workman in general the better has been their wages and conditions.

James P. Noonan, president of the International Brotherhood of Electrical Workers, of Washington, D. C., said that labor's concern was not purely a selfish one, but an "intelligently selfish one," for unintelligent selfishness they found did not pay. Thus through observations of the known economic laws, labor has been coming more and more into its own in power development. Labor has no quarrel with labor-saving machines, as it fully recognizes that power improves living conditions. Its extension has resulted in the employment of more men, a higher class of labor, and at better wages. Labor wants to know how best to cooperate in the elimination of waste in industry. Mr. Noonan made a plea for the union as the only voice of labor, just as the great national and international engineering and financial organizations expressed the opinions and aspirations of engineers and financiers.

Guido Semenza, of Italy, describing hydro-electric power development in this country, said that coal is directly connected with the needs and growth of civilization, and even in a country having no coal, as in Italy, hydro-electric power can never answer the entire requirements. There is a vast field for development of consumer demand in Italy, for against a per capita consumption of 700 kw.-hr. in Switzerland, there are but 117 kw.-hr. consumed in Italy. This is partly explained by the fact that electric heating is unnecessary in Italy, owing to more favorable climatic conditions. Water power has made possible for Italy its stable economic position, and it has been through private enterprise almost entirely, that Italy's power resources have been developed.

John Sandberg, of Norway, discussed the economy of power distribution, based on experience in Norway, but stated that Norway had built up a supply of cheap power through the development of domestic demand for electricity for cooking purposes. An unusual load and diversity factor had been created in Norway through methods discussed in his paper.

David B. Rushmore, of Schenectady, gave a brief abstract of Mr. Rice's paper, "New Fields of Research in Power." A more complete abstract of Mr. Rice's paper is given elsewhere in this issue.

Don Pedro M. Gonzalez Quijano, stated that Spain was not in an exceptionally advantageous position with regard to power development on account of depreciated currency but that she had unusually favorable natural advantages. Spain has been rather backward in the sciences, which has resulted in her enormous coal resources and her waterfalls remaining undeveloped.

Steam Generation and the Utilization of Fuel

ON THURSDAY morning W. H. Patchell, chairman of the session, presented in abstract a group of papers dealing with steam generation and the utilization of fuels. A paper by B. M. Gerbel, of Austria, stressed the well-known method of energy conservation by the use of prime movers supplying bled or exhaust steam to process work. Many plants, he said, still failed to avail themselves of these possibilities. In an interesting table he showed the energy thus wasted in various industries. Several interesting proposals were made, such as the interchange of heat and power between two neighboring plants, where one of the plants has an excess power consumption and the other an excess heat consumption. Again, waste heat from central stations can be used not only for district heating, but also for raising early vegetables in huge hothouses built close to the station.

In his paper "The National Economic Power of Solid Fuel in relation to its Scientific Utilization," Leonard C. Harvey (Great Britain) made a plea for the low-temperature carbonization of all raw coal, with fuel recovery of gas, oil and other byproducts, some of the carbonized products to be briquetted for household use and the remainder to be burned in pulverized form in central stations. Mr. Harvey recommended public control over all these processes.

The outstanding features of Swedish practice in steam-power production were outlined by H. A. Lundberg. Of particular interest was the method described for saving steam in pulp mills where the power load exceeds the heating load. Special governors have been developed whereby turbines exhausting to the process will take just the amount of steam needed for the process, any required excess of power being automatically supplied from hydro-electric stations. Attention was also called to the use of high-pressure boilers and the steam accumulator.

The accumulator was the subject of a special paper by J. Ruths, its promoter, of Stockholm. This device, which was described in *Power*, Aug. 28, 1923, stores up steam in the form of hot water under pressure. By using accumulators of sufficient capacity, the inequalities between the consumption of steam and its generation may be ironed out.

A review of current practice in the generation of steam power, by P. Junkersfeld and George A. Orrok (U. S. A.) attracted much attention. An abstract will appear in an early issue of *Power*. The statements of the present stage of American practice were of interest to European engineers, while American engineers were particularly interested in the tables giving data for a large number of important power plants.

Proposes Novel Furnace for Burning Pulverized Fuel

W. M. Selvey's (Great Britain) paper, "Pulverized Fuel for Boilers," gave particular attention to the question of grinding and the degree of fineness. He predicted a reaction from the present tendency to use extremely large furnace volumes for pulverized coal. The possibilities of "gyro" gasification were mentioned. In this the pulverized fuel is to be fired within a cylindrical brickwork structure similar in shape to a cyclone dust catcher, having a water trough at the bottom for ashes. The revolving flame of partly burnt material gives the necessary time element in the process. It is hoped to separate out the ash at this intermediate stage, which at a temperature of approximately 2,000 deg. F. is hardly up to fusing temperature. Thereafter the gas is burned with secondary air in the ordinary manner. The system is under construction in a large power station in Great Britain, but is not yet in operation, so that no practical comments can be made on it. It does, however, open a line of vision for dealing with the ash trouble. In spite of the political difficulties that engineers in England have to overcome, powdered fuel should be given a fair and early trial.

Discussing the paper of Messrs. Junkersfeld and Orrok, Charles H. Merz, consulting engineer, London, pointed out that when the important group of power companies serving the northeast coast of England decided some

six years ago to build a new station, his firm decided to adopt a pressure of 450 lb. together with the general cycle of progressive feed heating, steam reheating and air economizers suggested by Dr. S. Z. Ferranti some years previously.

It can now be definitely said that at North Tees even with a low stack temperature air heaters give much less trouble than the average water economizer. Nor does the use of preheated air cause trouble with the grate.

Mr. Merz did not think the same could be said of the boiler furnace. Presumably, that is the reason for the proposal to use the furnace walls for steam raising either by the insertion of tubes or in some other way. If, as is indicated in the paper, there is no deleterious effect upon the efficiency of combustion by surrounding the furnace with metal used for steam-raising purposes we must materially modify our idea of boilers.

It was perhaps partly with this in mind that he had seriously considered the use of the Yarrow boiler, which has been employed much more for marine purposes than for land purposes. Mr. Merz said that in England they were told that one of the advantages of using pulverized fuel was that most of the dirt in the coal goes into the atmosphere and is got rid of free of expense to the power station. Speaking from the national point of view is this not a retrograde step?

In reference to powdered-coal furnaces, Mr. Pokobradski spoke against the reduction in volume of the combustion chamber. He urged the importance of the net over-all as against the unit thermal efficiency and said that the main difference between the unit and central pulverized-coal systems was a matter of storage.

W. S. Monroe, of Sargent & Lundy, Chicago, speaking of ash disposal in powdered-coal practice, said that the experience at Lakeside and Cahokia had demonstrated that the amount of dust deposited over the surrounding country per unit of area was insignificant.

John Anderson Comments on Pulverized Fuel

John Anderson, of Milwaukee, said that there was no danger from coal-dust explosion if proper precautions were taken. He told of an explosion in a 22-in. main caused by an attendant sending through an aërated stream of powdered coal after some coal that had been allowed to remain in the pipe had become ignited, but the worst that happened was the blowing off of a 22-in. elbow and knocking a man's hat off. Only about 10 per cent of the ash escapes through the smokestack. It is not true that the unit plant takes less power than the central plant. With regard to investment they have built a modern-type 160,000-kw. turbine station with all the water channels, coal-handling apparatus, etc., for $82.80 per kilowatt.

A. E. Douglass, of the Fuller-Lehigh Co., said that the unit system had been used for 22 years in the cement mills of the United States. The power used is consideraly greater than for the centralized system, and the unit pulverizer grinds coarser at high ratings just at the time when fine grinding is desirable. Mr. Anderson added that the unit system is 6 per cent less efficient.

Col. Peter Junkersfeld, of McClellan & Junkersfeld, New York, said that pulverized coal had been used less than five years, stokers over 20 years. The first station to use pulverized coal has been holding the record for two years, and the newest station is now making an equally good record.

George A. Orrok, of New York, answering Mr. Merz with regard to the water-tube furnaces, said that Hel. Gate has had three boilers running almost a year with no repairs. The evaporation ranges from 4 to 19 lb. of water per square foot of heating surface, with a combined efficiency of boiler, superheater and economizer of over 92 per cent. Two 28-hour tests showed 91 per cent, and the over-all efficiency for the year was around 78 per cent. They will get the evaporation up to 23 lb. per sq.ft. per hour, but some of the small-tube boilers have done 28. When they use powdered fuel, they will install a dust catcher between the boilers and the chimney, not that they believe it necessary, but to be in the position of having taken even an excess of caution to avoid trouble to the neighbors by "cinders."

Mr. Harvey objected strongly to mixing pulverized coal with air and transmitting or conveying it in that way. He reminded Mr. Orrok that with powdered coal there would be only an impalpable powder in the stack and no cinders.

David Brownlie, of London, said that the world is using some 1,250,000,000 tons of coal and lignite per annum, of which 500,000,000 tons is burned under stationary land boilers, with an average efficiency of less than 58 per cent. The world is wasting 50,000,000 tons of good coal a year because it will not use refuse fuel. He urged the desirability of an international test code for the testing of boilers so that results might be comparable. Mr. Brownlie claimed priority of invention of the Cornish boiler for Richard Trevethick and said that the mechanical stoker was invented before the water-tube boiler.

Sir Robert Hadfield accompanied the presentation of his paper on "Fuel Economy and the Measurement of High Temperatures" by an extensive exhibit of heat and temperature-measuring instruments, plotted results of tests, etc., and an original painting by Turner of an eruption of Vesuvius, the colors in which had suggested the development of a color chart for temperature measurement which had proved surprisingly accurate. The discussion turned mainly on possible uses for metals that retained their tensile and other properties at high temperatures.

Opinions Differ on Byproduct Power

In discussing a paper by J. Tomaïdes on "Heat Economy in Austria" and that of B. M. Gerbel on "The Reciprocal Utilization of Waste Energy," stress was put upon making more use of exhaust steam. George A. Orrok claimed that cases were very rare where the power user would not gain by buying his power and burning fuel especially to make such low-pressure steam as he required because he could turn over the capital otherwise required for power generation much oftener and make a much greater profit upon it if put into his legitimate business, leaving the production of power to those who were making a specialty of it.

A. F. Enström said that the demand for heat and power often did not synchronize and told of the Ruths accumulator.

J. Ruths, of Stockholm, said that the use of his accumulator would allow a much larger production with the same or less boiler-heating surface and that he did not at all agree with Mr. Orrok's views as to the inadvisability of a manufacturer who has a considerable use for heat for manufacturing purposes or warming buildings making his own power and using his exhaust.

(Report will be continued in Aug. 5 issue.)

Mechanical Forces in Power Transformers

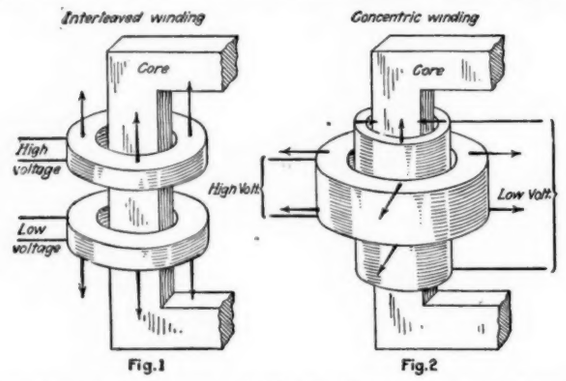
An Elementary Explanation of How Mechanical Forces Are Set up in Static Transformers Due to Short-Circuits or Faulty Switching, That Have Resulted in Failure of the Windings

THE present trend toward the installation of large-capacity transformers has several well-founded reasons. In common with prime movers, generators and motors the efficiency of transformers rises with their capacity. Changing from one voltage to another, with one per cent or less loss in the transformation on machines of about 15,000-kva. capacity or more, is today not unusual. At the same time the cost of such large machines per kilovolt-ampere will be considerably lower than for much smaller units. The modern idea of great national superpower systems, having a large number of individual trunk-line systems tied together through transformers, points to a further necessity of having only a few large-capacity transformers, to reduce the number of individual tie-in points. Finally, the great reliability of design and construction of large transformers, making them one of the safest links of a power-transmission system, warrants their extensive usage.

Considerations in Design of Transformers

It may appear from this that only large transformers are given exceptional considerations in design and manufacture. This, of course, should be understood relatively only. Difficulties of a minor character on small transformers rise to a considerable magnitude as the capacity goes up, and can no longer be neglected. This applies particularly to mechanical forces occurring under certain conditions in the windings of transformers.

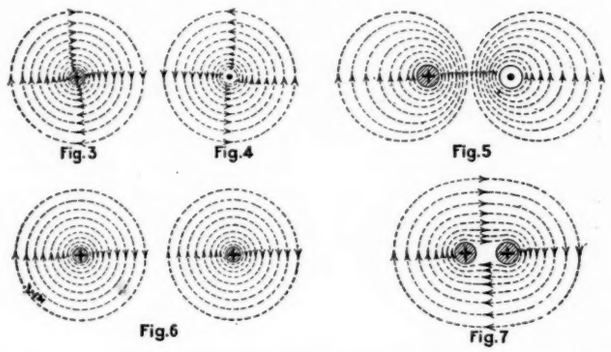
Frequently, transformers are called "static" transformers (a nomenclature very common in England) because they contain no moving parts. But only a carefully designed and well-balanced transformer will represent a freedom from motion under the sometimes



Figs. 1 and 2—Arrows indicate direction of mechanical force between the primary and secondary windings in transformers

enormous stresses set up in large machines under heavy overloads or short-circuits. As a matter of fact it may be mechanically easier to design a smoothly rotating machine than a large-capacity transformer winding, because any motion in the parts of the latter will usually spell destruction.

The larger and the more extended power systems become, the more frequently will occur unavoidable short-circuits due to failure in cables, accidents or faulty switching. Generators and transformers will tend in such a case to deliver suddenly many times their normal capacity into the fault until it is cleared. This energy manifests itself as mechanical forces, tending to deform



Figs. 3 to 7—Show how mechanical forces are produced between two electrical conductors

and to dislocate the windings, as shown schematically for the two main methods of placing high- and low-voltage windings around the iron core of a transformer, Figs. 1 and 2.

How Mechanical Forces Are Produced

How these forces are set up will be understood by referring to Figs. 3 to 11. When an electric current flows through a circuit, it sets up a magnetic field which rotates about the conductors in a direction depending upon the direction of the current. If the direction of the current is away from the observer, as in Fig. 3, the magnetic field will rotate in a clockwise direction; with the current flowing toward the reader, the magnetic field rotates in a counterclockwise direction, as in Fig. 4. By comparing the direction of the magnetic fields between Figs. 3 and 4, it will be seen that both are in a down direction. If the two conductors are brought near each other, as in Fig. 5, repulsion is set up between the two magnetic fields, which will tend to cause the conductors to separate.

If the current is in the same direction in the two conductors, then the magnetic fields between them will have opposite directions, as in Fig. 6. If two such conductors are brought near to each other, the two magnetic fields will oppose between the conductors with the result that the lines of force combine and surround the two wires as in Fig. 7. The lines of force in a magnetic field act like elastic bands in tension. Therefore, in Fig. 7 the lines about the two conductors tend to pull them together, where in Fig. 5 they have a wedging effect and tend to force the two conductors apart. Where the currents are large, such as obtained under short-circuit conditions, these forces become very great.

The forces that are set up about two conductors carrying current are also present in coils or between coils. For example, in the coil Fig. 8 the lines of force passing through the center of the coil repel each other and tend to expand the coil in all directions, in very much the same way that a liquid or gas under pressure in a closed vessel tends to expand the container so that all surfaces become circles. For this reason a circular coil is much better suited to withstand the mechanical forces set up by magnetic fields than any other shape. If a square coil, as shown in Fig. 9, is used, the mechanical forces set up inside of the coil due to the repulsion of the lines of force, will tend to make it take a cylindrical shape. There are many cases on record where rectangular coils have been destroyed under heavy short-circuit conditions due to the forces set up in them.

Forces that Tend to Crush the Coils

There is another force set up about the turns in the coils, which tends to crush them together. The lines of force leave at the *N* and enter at the *S* pole, and in doing so they completely surround the turns of the coil. As previously pointed out, these lines act like elastic bands in tension and tend to grow shorter and in this way exert a force that tends to reduce the space occupied by the turns in the coil. For this reason coils that are liable to be subjected to heavy currents and magnetic stresses should be substantially constructed. If they are not, the turns are liable to vibrate, destroying the insulation and causing short-circuits.

The magnetic stresses that exist between conductors also exist between two or more coils, but to a greater degree on account of the energy being concentrated in a comparatively small space. If like poles of two coils are brought together, as in Fig. 10, they will repel each other as indicated by the lines of force between the coils. This is similar to the conditions that exist in the arrangement of transformer coils in Fig. 1. The

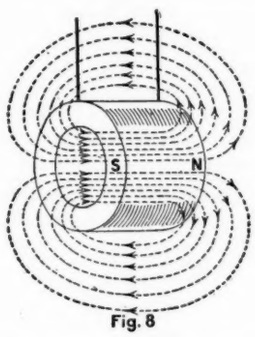


Fig. 8

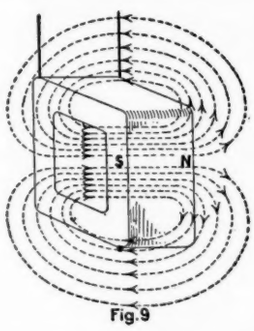


Fig. 9

Figs. 8 and 9—Magnetic field in center of coil tends to cause the coil to take a cylindrical form

current in the low-voltage winding will be in an opposite direction to that in the high-voltage winding, consequently the coils will have opposite polarity, as in Fig. 10. Therefore the coils in Fig. 1 will have magnetic stress set up between them that will tend to force them apart as indicated by the arrows.

If a cylindrical type of coil is used, as in Fig. 2, the forces will be in a direction to push the outside coil away from the core and the inside coil toward the core. Why this is so will be understood by referring to Fig. 11, which shows a cross-section through two cylindrical coils having opposite polarity, as would the primary and secondary coils of a transformer. In Fig. 11 the direction of the lines of force from the coils is such as to pass in the same direction through the annular space between the two coils. The magnetic forces between the two coils repel each other and tend to expand the outside coil and compress the inside one. Where the coils have an iron core the lines of force concentrate in the core and exert a force which tends to pull the inside coil toward the core.

In large-capacity transformers these forces may amount to many tons and frequently exceed the weight

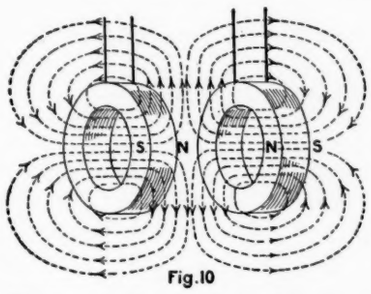


Fig.10

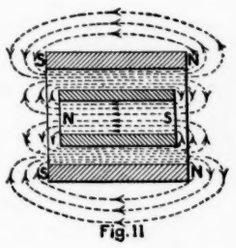


Fig.11

Figs. 10 and 11—Show how magnetic fields of two coils produce mechanical forces

of the machine. To give a concrete example, it may be mentioned that a 10,000-kva. single-phase transformer, weighing complete with coil approximately 21 tons, may have to stand, under short-circuit, internal forces of up to 22½ tons. To take proper care of the necessary bracing, safety to withstand such a suddenly applied pressure will obviously require considerably more attention than is required to cope with a few hundred pounds on a small transformer.

Bracing the Coils to Prevent Distortion

Reliable methods to calculate exactly the mechanical forces gave the designer of transformers the basis for providing adequate bracing of windings and to allow for an ample safety margin. Wood, used in years gone by to support windings, has been entirely replaced by more reliable materials, such as porcelain and structural steel. Veritable bridge girders may be found today on the tops and bottoms of transformer cores to resist any attempted dislocation of the windings. The forces within the coils themselves have been successfully taken care of by shaping the coils so as to equalize them over their entire circumference. This is possible only with coils of circular form. A coil of any other but circular form will tend to become circular under the stresses of a short-circuit, as explained in the foregoing. On concentrically arranged cylindrical high- and low-voltage windings great care is being taken to assemble the two windings symmetrically to each other in order to minimize the forces. Only judiciously placed voltage taps in such a winding will prevent an unbalancing of the two windings

Although the operator may have no control over the design of transformers after they are built and installed, he can do much to prevent excessive mechanical force being set up in the windings by affording proper protection to the units on the system and eliminating faulty switching. More than one transformer failure has been caused by trying to tie two systems together through a transformer bank, when the systems were out of phas

Internal-Combustion Engines at the British Empire Exposition

By JOHN B. C. KERSHAW*

ONE of the outstanding features of the power plant machinery exhibit at Wembley is the internal-combustion engine. In the booths of the several manufacturers are found units ranging from the small portable gasoline engine to large heavy-oil engines of both the air-injection and solid-injection types. One of the interesting impressions gained by the visitor is the large number of British shops long identified with the steam engine, that have taken up the building of the internal-combustion engines.

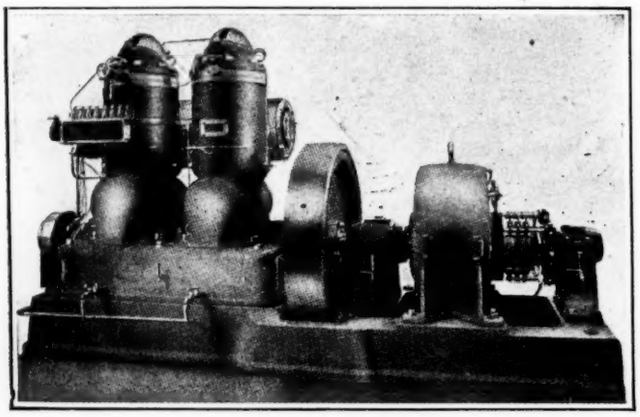


Fig. 1 (Above)—Beardmore semi-Diesel

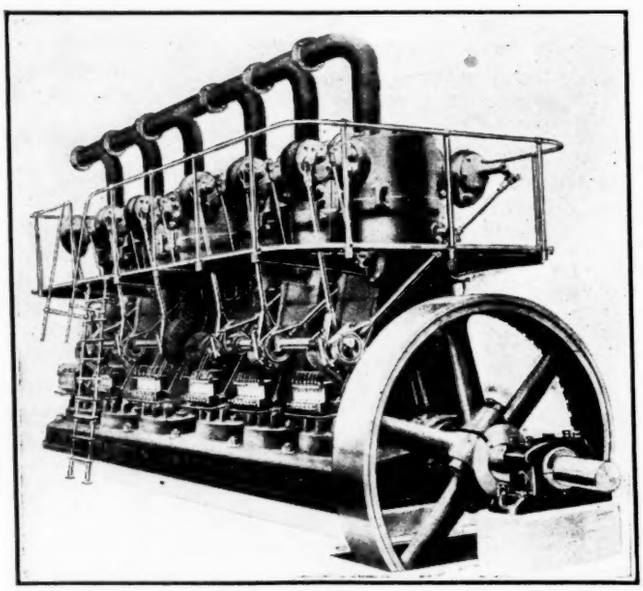


Fig. 2 (Right)—New engine of Hornsby & Ruston

Fig. 3 (Lower Right)—Tangyes build horizontal oil engine

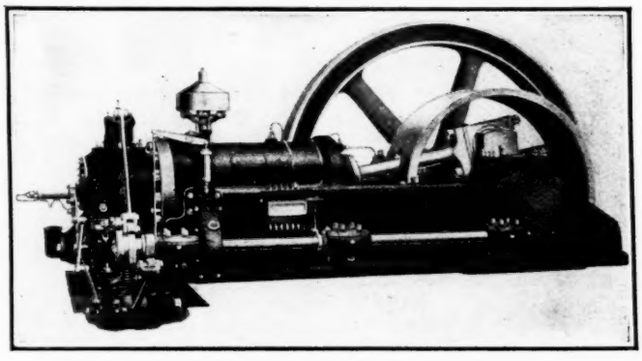
From the number of engines exhibited of the several types, it appears that the cold-starting solid-injection oil engine holds the position of favorite. Of this type there are units covering a wide range of capacity, of both the two-stroke and four-stroke cycle.

In Fig. 1 is shown a Beardmore semi-Diesel or hot-surface engine developed for both stationary and marine auxiliary service. This is a two-stroke-cycle unit, and is offered in sizes from 30 hp. upward. Each cylinder is provided with a partly uncooled combustion chamber which, after starting automatically, maintains a temperature sufficient to ignite the oil charge. The initial firing is effected by the heating of a starting pin by means of a torch. The engine possesses no unusual feature of distinction, being similar to a number of other makes. The fact, however, that a firm building Diesel engines has taken up the semi-Diesel is indicative of the general trend among British manufacturers.

Ruston & Hornsby, successors of the first builders of the Ackroyd, the automatic-ignition oil engine, show a six-cylinder unit of their new vertical design, Fig. 2. This is a solid-injection cold-starting engine of medium compression. In the face of the almost universal adoption of the box frame the cylinder of this unit is supported by *A* frames. The method of actuating the valves by eccentrics instead of cams is somewhat unusual, as also is the design of the valve cages, these cages entirely inclosing the valves, which are set horizontally. The fuel consumption compares favorably with that of air-injection Diesels.

Tangyes of Birmingham, who are well known for the steam engines they produce, exhibit a 260-hp. horizontal-four-stroke-cycle solid-injection engine, illustrated in Fig. 3. This is a cold-starting medium-compression engine, and its combustion chamber is provided with a sheath to retain enough of the heat of combustion to insure light load firing.

The Vickers-Petters, Fig. 4, is manufactured in capacities from 10 to 500 hp. The builder



*British Correspondent

states that over 275,000 hp. have been built of this two-stroke-cycle semi-Diesel. The objection often raised to the use of a torch for the initial heating of the combustion chamber or hot bulb has been eliminated by the use of an electric coil, which is connected to a battery and supplies enough heat to ignite the first

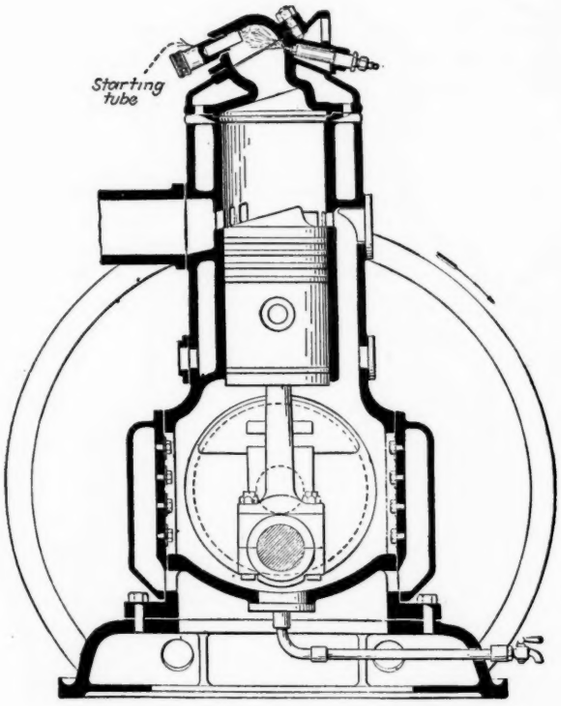


Fig. 4—Vickers-Petters semi-Diesel

few oil charges. With the engine once started, the coil is screwed back into a recess away from the heat.

A comparatively new comer in the oil-engine field, A. G. Mumford & Co., exhibits a light high-speed semi-Diesel or hot-surface engine, Fig. 5. Being built in small capacities and high speeds, the unit is intended for use in services where the gasoline engine is largely employed. This machine does not follow the general British practice of using the crankcase as the scavenging air pump, but by the insertion of a partition at the lower end of the cylinder makes the space between the piston and this partition serve as the air pump. This necessitates the employment of a crosshead, which, although increasing the engine's height and first cost, doubtless reduces cyclinder wear and permits a greater piston wall clearance.

W. Beardmore & Co., Ltd., have long held the Tosi Diesel license for Great Britain and have developed this air-injection engine along lines somewhat at variance with the Italian machine, as will be observed from Fig. 6. In every oil engine the question of effective cooling of the head is serious by reason of the space taken up by the exhaust, air and fuel-valve cages. If the valves be made large enough to accommodate the entrance and exit of the cylinder contents without unduly high velocities, the cooling spaces are decidedly limited. Beardmore makes use of two valves in the head, and by means of a deflector valve or damper these valves are made to serve both as admission and as exhaust valves. The two valves can then be made much smaller than in the standard construction, where one serves for the admission and one for the exhaust.

An attractive exhibit of oil engines is made by Mirrles, Bickerton & Day. Various sectionalized parts are shown, giving the visitor a comprehensive idea of the functioning of each piece as the engine is rotated by an electric model. For example on a 150-hp. unit on exhibit, the side of one cylinder has been cut away, revealing the valve gear, and as the engine rotates, the sequence of valve action may be fully studied. This firm is now a licensee of the Swedish-Nobel Co. and will build the Nobel two-stroke-cycle marine engine.

The desire to obtain a greater horsepower per pound of metal has prompted many manufacturers to engage in the development of double-acting engines. On the surface it would seem that the matter of making a cylinder double-acting is a very simple one. However, more enters into the design than a mere closing of the lower end of the cylinder. It has been found that the stresses set up in the lower head far exceed those in the upper head. The locating of the necessary valves without unduly decreasing the cooling is difficult. The

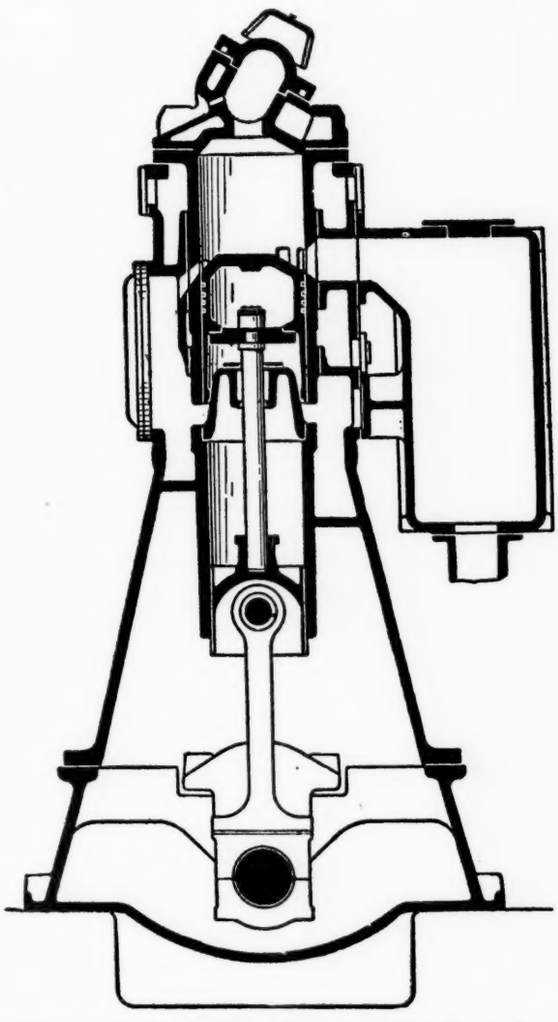


Fig. 5—A. G. Mumford two-stroke-cycle engine

North British Diesel Engine Co. has endeavored to overcome the difficulties by making a double-acting vertical engine on the two-stroke-cycle principle. To avoid the placing of scavenging valves in the heads, the cylinders are made to shift vertically so that their ends by passing the cylinder heads uncover the scavenging air ports; in effect the action is similar to the Knight

sleeve-valve motor. The builder shows a model of the engine, one cylinder being sectionalized to permit a study of the valve action. This machine was described in *Power* June 17.

Hick, Hargreaves & Co. show air-injection Diesels; this concern manufactures units of a wide range of capacities.

An interesting model of a sliding-cylinder double-acting Diesel is shown by the North British Diesel

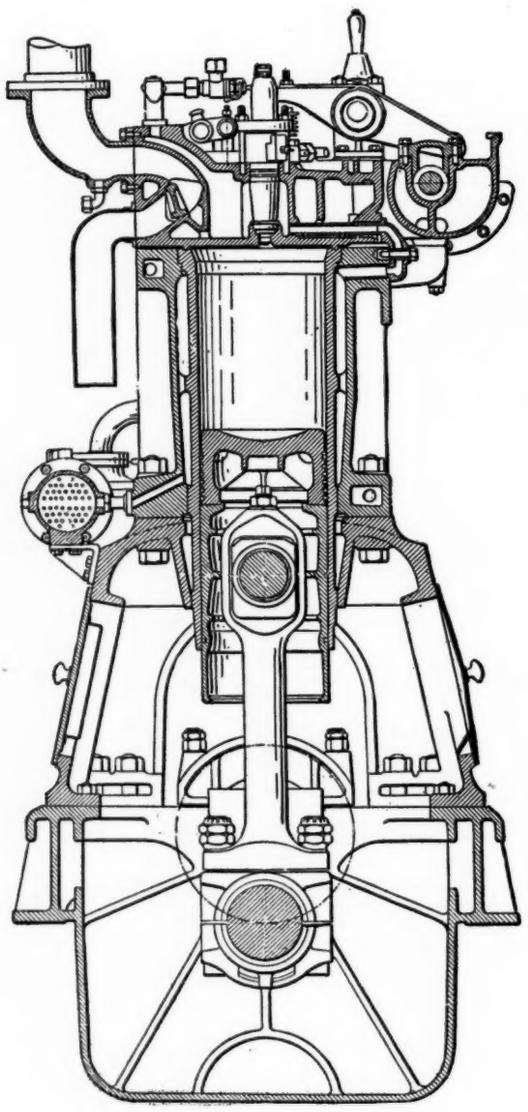


Fig. 6—Beardmore-Tosi Diesel

Engine Corliss. This unit was described in *Power* June 17.

There are in addition many small gasoline engines and a few large gas engines, among the latter being a vertical unit built by the National Gas Engine Co.

The dangers attending any interference with the revolving element of a large steam turbine will be appreciated when we consider it is a revolving mass having a peripheral speed of 800 to 1,000 ft. per second and weighing from 30 to 40 tons, while the time from first indications of increasing vibration to a serious injury of the unit may be less than twenty seconds.

Thermal Efficiency of Large Steam Turbines

In a paper, "New Fields of Research for Power Development," presented at the World Power Conference, held in London, England, June 30 to July 12, E. W. Rice, of the General Electric Co., said that the early steam-turbine generator unit had a thermal efficiency of about 14 per cent. The term "thermal efficiency of the steam-turbine electric unit" is used as the ratio of the B.t.u. in the kilowatt-hours delivered by the generator to the busbars, divided by the B.t.u. in the steam supplied to the turbine, less the B.t.u. returned to boilers in the condensate. By a long series of difficult researches as to the flow of steam in nozzles and buckets by increasing the steam pressure, improvement in vacuum and general increase in size of units, the thermal efficiency of the steam-turbine electric unit has been greatly improved.

In machines of 30,000 to 50,000 kw., with steam pressures of 230 to 250 lb., steam temperature 625 to 650 deg. F., vacuum 29 in., without reheating between stages, a thermal efficiency of about 27 per cent has been obtained. The table below sets forth the progress made in the efficiency of such units in the United States from 1903 to 1923:

Year	Apparatus	Gage Pressure per Sq.In.	Steam Temp. at Throttle, Deg. F.	B.t.u. per Kw.-Hr.	Thermal Eff. of Turbine Unit, Per Cent
1903	5,000-kw. vertical turbines.....	175	378	23,500	14.5
1914	20,000-kw. horizontal turbines...	200	588	14,500	23.6
1923	30,000- to 35,000-kw. horizontal turbines average good practice	230	625	13,350	25.6
1923	Most efficient stations 30,000 to 45,000 kw. turbines.....	230 to 250	625 to 650	12,500	27.2

In units now under construction of 30,000 to 50,000 kw., with steam pressure of 375 lb., temperature 700 deg., vacuum 29 in., without reheating between stages, but with steam extraction for feed heating, an efficiency of about 30.5 per cent is expected.

In units now under construction of 50,000 to 60,000 kw., steam pressure 550 lb., temperature 725 deg., vacuum 29 in., with single reheating between stages, an efficiency of about 33.1 per cent is expected.

A study has also been made of units of 100,000 kw. operating at 1,200 lb. steam pressure, temperature 725 deg., vacuum 29 in., reheating twice between stages, which indicates a possible efficiency of about 38 per cent.

The results expected from these steam-turbine electric units are given in the following table:

Year	Apparatus	Gage Pressure per Sq.In.	Steam Temp. at Throttle, Deg. F.	B.t.u. per Kw.-Hr.	Thermal Eff. of Turbine Unit, Per Cent
1924	New stations, 30,000- to 50,000-kw. turbines, steam extraction for feed water, but without reheating between stages....	375	700	11,200	30.5
1924	New stations being erected, 35,000 to 60,000 kw., steam extraction and single reheating between turbine stages.....	550	725	10,300	33.1
	Proposed new stations, 100,000-kw., single reheating between stages.....	550	725	10,100	33.8
	Proposed new stations, 100,000-kw., two reheatings between stages.....	1,200	725	9,000	38

During the period of development of the steam-turbine electric unit, great improvement has taken place in the steam boiler due to increased size, improved methods of firing, superheating, increased temperature of the feed water, etc. These improvements in both the steam boiler and the steam-turbine electric units

have co-operated to advance the "thermal efficiency" of the combined "plant efficiency" from about 10 per cent in 1903 to about 19 per cent in the modern station using 30,000- to 45,000-kw. turbines without reheating.

This improvement in efficiency of steam-turbine electric plants is disclosed in the following table:

Year	Apparatus	Gage Pressure per Sq.In.	Steam Temp. at Throttle, Deg. F.	B.t.u. per Kw.-Hr.	Equiv. Lb. of Coal per Kw.-Hr.	Thermal Eff. of Plant, Per Cent
1903	5,000-kw. vertical turbines	175	378	37,000	2.64	9.2
1914	20,000-kw. horizontal turbines	200	588	22,000	1.57	15.5
1923	30,000 to 35,000 kw. horizontal turbines average good practice	230	625	20,000	1.43	17.1
1923	Most efficient stations 30,000 to 45,000 kw. turbines	230 to 250	625 to 650	18,000	1.28	19

"Plant efficiency" takes account of all losses in boilers, flue and station operation. It is equal to the B.t.u. equivalent of a kilowatt-hour (3,414 B.t.u.), divided by the B.t.u. in coal consumed per kilowatt-hour.

Coal is assumed to contain 14,000 B.t.u. per lb., which coal is available to the large companies on the eastern seaboard of the United States.

In stations now being erected with units of 30,000 to 50,000 kw., increased steam pressure and steam extraction for feed water, but without reheating between stages, a thermal efficiency of slightly under 22 per cent is expected. Other stations now being erected with units of 35,000 to 60,000 kw., 550 lb. pressure with steam extraction and single reheating between stages, and operating on "base loads"—that is, about 100 per cent load factor (capacity factor)—a "plant thermal efficiency" of slightly under 24 per cent is expected.

In stations with units of 100,000 kw., 550 lb. pressure, with single reheating between stages, a plant efficiency of 24.1 per cent is expected. It is also estimated that if the pressure were raised to 1,200 lb. and reheating twice between stages were adopted, a plant efficiency of about 26 per cent would be possible.

The results expected from the latest stations, using the largest steam-turbine electric units which are either under construction or being considered as possibilities of the near future, are shown in the following table:

Year	Apparatus	Gage Pressure per Sq.In.	Steam Temp. at Throttle, Deg. F.	B.t.u. per Kw.-Hr.	Equiv. Lb. of Coal per Kw.-Hr.	Thermal Eff. of Plant, Per Cent
1924	New stations, 30,000- to 50,000-kw. turbines, steam extraction for feed water, but without reheating between stages	375	700	15,800	1.13	21.7
1924	New stations being erected, 35,000- to 60,000-kw., steam extraction and single reheating between turbine stages	550	725	14,500	1.04	23.6
	Proposed new stations, 100,000-kw. single reheating between stages	550	725	14,200	1.01	24.1
	Proposed new stations, 100,000 kw., two reheatings between stages	1,200	725	12,800	0.91	26.6

Twenty-seven of the largest steam-electric stations in the United States sold in 1923, 18,500,000,000 net kw-hr. If this output had been generated entirely by the stations equipped with the latest commercial apparatus shown in the table above, the annual saving in coal consumption in the twenty-seven plants would have been about 5,000,000 tons.

These twenty-seven stations produced about 40 per cent of the total kilowatt-hour output sold by steam central stations in the United States in 1923. As the smaller stations were less economical, it is fair to assume that if the 1923 output had been supplied by the most economical units in the large stations, a possible saving of not less than 12,500,000 tons of coal would have been realized.

Production and Costs of Central Heating

The returns from 27 steam-heating companies throughout the United States are tabulated and analyzed by the committee on operating statistics, of the National District Heating Association, in a paper presented at the recent convention in New York.

The largest producer of steam during the year 1923 served 2,057 customers, with a total of 2,285,980,000 lb. of steam. The second largest producer had only 84 customers, yet generated 1,041,906,000 lb. The former showed a maximum of 836,000 lb. supplied per hour with a load factor of 25.3 per cent, and the latter a maximum of 360,000 lb. per hour with a load factor of 28.3 per cent.

Condensation meters were much in the majority, totaling 8,585 against 198 flowmeters. Steam pressures at the customers' service valves varied from ½ lb. to 175 lb., while 9 companies supplied all or part of their steam at pressures in excess of 20 lb. The average steam sold per customer was 1,010,000 lb., while the minimum and maximum were 271,000 and 10,600,000 lb. respectively. The average loss (partly estimated) as produced by condensation, leaks, auxiliaries, traps, etc., between the boiler header and the customer's meter, in per cent of the gross, averaged 19.6 per cent with a maximum and minimum of 33 and 6.5 per cent respectively.

The unit for hogged fuel for the two companies reporting on this consisted of about 200 cu.ft. of approximately 4,000 lb. per unit. This contained an average of 4,435 B.t.u. per lb. The income per 1,000 lb. of steam for 25 companies averaged $0.867, varying from $0.497 to $1.240. The cost per 1,000 lb. of steam for fuel only was given as $0.423 from coal, $0.545 from oil, and $0.145 from hogged fuel. The theoretical efficiency with a factor of evaporation of 1.1 is 54.8 per cent for coal, 42 per cent oil, and 51.5 per cent for hogged fuel.

The average load factor was 23.2 per cent, while the minimum and maximum were respectively 12 and 40.8 per cent. Heating requirements in pounds of steam per sq.ft. of radiation for 22 companies averaged 498-lb., varying from the minimum of 330-lb. to the maximum of 700-lb. The mean temperature during the heating season for 22 companies was 42.8 deg. F.

The sentiment was five to one in favor of thermostatic control, and about equally divided between welded and screwed piping, while 13 out of 25 considered the business as profitable at the prevailing rates.

Hot-water heating for seven companies was analyzed, indicating that the average income per square foot of radiation was $0.386, with a minimum of $0.208 and a maximum of $0.436. One company out of seven regarded the business as profitable. Heating requirements for the season per square foot of radiation amounted to 660,000 B.t.u., and heat delivered per ton of fuel amounted to 17,000,000 B.t.u., with an average efficiency of 71 per cent. The customers per block served varied from 2.3 to 12.2, making an average of 7.4.

The Advent of the Compound Compression Refrigerating System

BY LEWIS J. SFORZINI

CERTAIN of the large cold-storage interests pushed for space in highly congested, valuable-space districts and with the offer of extremely favorable electric power rates from the public utilities, sought to substitute for their bulky absorption machinery the more compact compression equipment and made elaborate experiments with two-stage ammonia compression which proved highly successful. The development of light plate valves in horizontal double-acting compressors has made possible high speed and hence less floor space for compressors per ton of refrigeration, and has introduced compound compression into certain fields formerly served satisfactorily by slow-speed single-acting compressors.

Compound compression provides a pressure intermediate between that of the head and suction pressures. In all commercial machines this intermediate pressure always has an ammonia saturation temperature considerably lower than that of the superheated low-pressure discharge. Four practical methods are available for reducing the temperature of the superheated ammonia gas after leaving the low-pressure cylinder and before entering the high-pressure cylinder, each reducing the power required per ton of refrigeration over a single-cylinder compressor. One of the latest arangements of the compound compression system of refrigeration is shown in Fig. 1. Shell-and-tube equipment is employed for the intercooler, gas precooler, condensers and brine coolers; all this apparatus proper being without a single gasketed joint.

The receiver contains anhydrous ammonia which is forced through the first expansion valve into the expansion cooler, which is under intercooler pressure. The drop from the receiver to the lower pressure causes part of the liquid ammonia to evaporate and cool the remainder to a temperature equal to the saturated for the intercooler pressure. The cooled liquid is drawn off the expansion cooler at a point above the inlet and forced through the second expansion valve into the brine cooler. The heat from the brine evaporates the liquid ammonia into a low-temperature gas. This

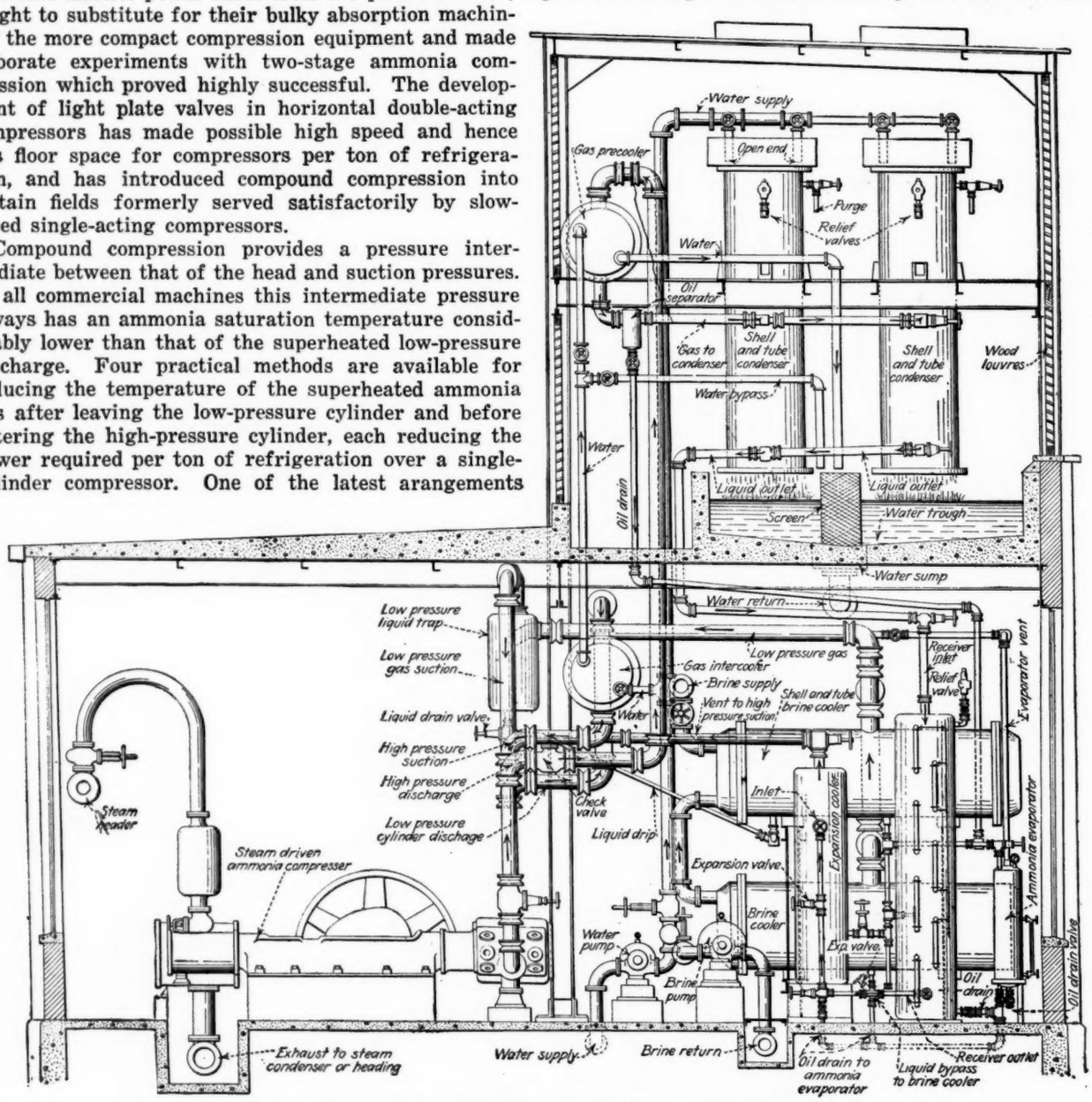


Fig. 1—Layout of compound compression refrigerating plant

gas passes into the low-pressure suction of the compressor, where it is compressed practically adiabatically to a higher pressure and discharged as superheated gas into the intercooler. Water circulated through the tubes of the intercooler cools the gas to within 5 to 10 deg. F. of the water temperature. The gas then leaves the intercooler and on its way to the high-pressure suction, encounters a smaller stream of colder ammonia gas coming from the expansion cooler at a temperature corresponding approximately to the saturated for the intercooler pressure. The result is a gas at a lower temperature than that of the water intercooler, but somewhat higher than the saturated temperature corresponding to the intercooler pressure.

The High-Pressure Side

In the high-pressure cylinder the gas is further compressed, again practically adiabatically, resulting in another rise in temperature and pressure. The gas is now discharged in a superheated condition under high pressure to a gas precooler, the function of which is to cool the gas to within 10 or 20 deg. F. of the condensing temperature. Leaving the precooler, the gas passes through an oil separator where the greater part of the lubricating oil carried over from the compressor is precipitated. The oil collected in the separator may be periodically removed into a pail or piped to an evaporator as shown. Leaving the oil separator, the gas enters the condenser and flows into the receiver. The drain lines from the condenser to the receiver are made of ample size and pitch to the receiver so that no equalizing line is required. The expansion cooler vent line to compressor and the liquid line to brine cooler

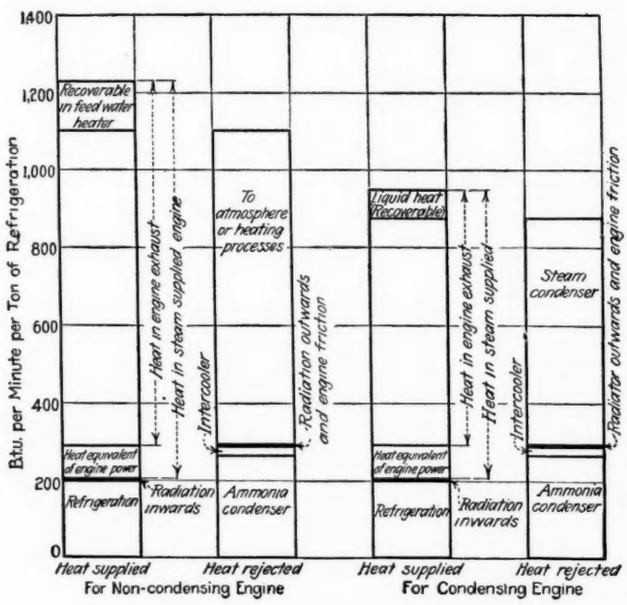


Fig. 2—Heat balance of refrigerating plant

must be insulated with cork or other appropriate insulation.

It is seen that in the compound compression system, in addition to radiation inward, heat is supplied at two points—in the cooler and in the compressor, where mechanical energy is converted into heat. Heat is removed at two points besides radiation—at the condenser (including the gas precooler, which may be considered as part of the condenser surface) and in the intercooler. In addition, power is supplied to the circulation-water pump.

There are four practical methods of compound compression other than that already described: (1) Water intercooling only may be used and the expansion cooler omitted; (2) water intercooling may be omitted and liquid ammonia from the receiver injected into the gas as it leaves the low-pressure discharge; the gas

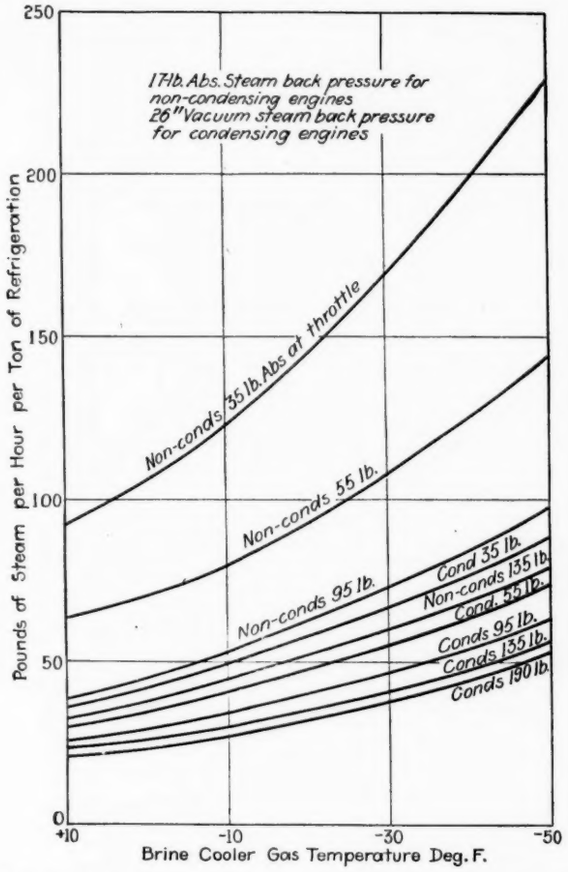


Fig. 3—Influence of steam pressure on plant economy

then enters the expansion cooler where its volume is augmented by the vented gas and any entrained ammonia liquid is precipitated into the expansion cooler, which acts as a separating trap for the gas; (3) a combination of water intercooling and liquid injection might be used; (4) liquid injection may be used to cool the gas, and the liquid from the receiver put through a coil in the intercooler under receiver pressure and cooled by evaporation of ammonia around the coil under intermediate pressure.

Intercooling Processes

With water intercooling alone or with water and expansion intercooling for all ordinary conditions, it is impossible to reach the saturation temperature at the intercooler pressure. When liquid injection is used alone or in conjunction with any of the other methods of intercooling, it is possible to reach this temperature, but in practice it is safer to stay somewhat above it to eliminate any risk of drawing ammonia liquid into the high-pressure suction.

Fig. 2 gives the heat balance of a steam-driven two-stage ammonia compression system operating between the pressure limits of 18.3 lb. and 165 lb. abs., for

both condensing and non-condensing steam-engine operation. Water intercooling only is assumed. The diagram is worked out on a B.t.u. per minute per ton of refrigeration basis, so that each unit area represents B.t.u. per minute per ton of refrigeration. The heat-supplied diagrams show the three sources of heat: 200 B.t.u. per minute per ton, which is the refrigeration heat, is constant regardless of the head and suction pressures, radiation inward through the insulation, the low temperature piping and equipment, and the steam

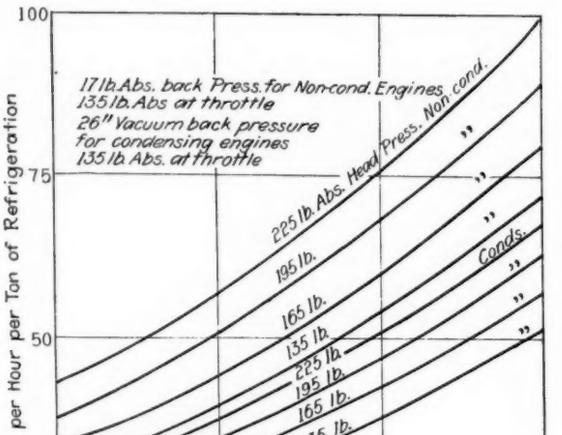


Fig. 4—Effect of high head pressure on steam consumption

heat. Of the steam heat, the lower area, called the heat equivalent of engine power, is converted into work at the compressor piston; the greater part of this goes to augment the ammonia gas pressure and temperature, the balance is lost in friction. The heat-rejected diagram indicates the amount of heat rejected at each of the four rejection points.

Condensing Operation

For the condensing engine all the heat in the steam exhaust, except the heat of the liquid of the steam, which is recoverable, is rejected in the steam condenser. For the non-condensing engine the exhaust steam heat, which is the bulk of the original steam heat, is rejected either to the atmosphere or to heating processes. If all the steam rejected from a non-condensing engine is used up for heating processes, the only heat chargeable to power or to ammonia compression, is the heat equivalent of engine-power area in the heat-supplied diagram. This heat, together with the refrigeration heat, represents the three smaller areas in the heat-rejection diagram. The remainder of the steam is used for heating or heating processes, hence refrigeration is produced at an extremely small power cost. If part of the heat is used in such processes and part rejected to atmosphere at certain ratios to each other, the heat efficiency might still be greater than for the condensing-engine system.

If an electric-driven compressor were used and power purchased from a large central station with large capacity turbo units, the heat actually consumed in the refrigerating plant would be only the heat equivalent of engine power plus the heat equivalent of the circulating water pump power; the total heat actually consumed under such conditions, even after allowing for all electric transmission losses, may be equal to or lower than that of a condensing steam-driven refrigerating plant.

Steam Consumption with Different Pressures

It is universally understood that the efficiency of a properly designed steam engine increases with an increase of steam pressure; superheat also produces an increase of efficiency. Fig. 3 gives the probable steam consumption per ton of refrigeration for steam engines supplied with steam at various pressures, the head pressure being constant at 165 lb. absolute. Water intercooling only is assumed, for other methods of intercooling the steam consumption will be less. The steam conditions for both condensing and non-condensing are given in the chart. It will be observed that increasing the steam pressure for both condensing and non-condensing operation, up to 95 lb. abs. produces very large decreases in steam consumption, so that it practically never pays to operate at lower pressures. The upper limits of steam pressure and also the desirability of employing superheat for condensing or non-condensing plants are largely economic questions, each plant presenting a separate problem.

Fig. 4 shows the effect of changes in head and suction pressures on the steam consumption for both condensing and non-condensing plants, being assumed the steam rate of the engine is not of great importance if the exhaust is used for process heat. Increase of head pressure increases the steam consumption; decrease of suction-gas temperatures also increases the steam consumption.

Most compound compressors are now built of the high-speed type with plate valves, so that the lubricating system is of paramount importance and must be positive and free from clogging. In the slow-speed compressors slight defects in the oiling system could be discovered before much damage is done, but any slight defect in the higher-speed compressor oiling devices will cause the bearing metal to run and result in a shutdown. The light valves are easily damaged or caused to leak by grit or pipe scale, so that a fine screen strainer of ample area should be located at each suction as near the compressor as possible.

In low-temperature work the low-pressure cylinder is under a vacuum for part of the stroke, and unless the stuffing box is of the proper design, air is liable to enter the system; in fact, even with a good stuffing box, some air will enter. This air, together with other non-condensable gas, will collect in the lower part of the condenser and upper part of the liquid receiver and result in excessive head pressures unless proper care is taken to eliminate these gases as fast as they accumulate. The proper place to remove them, as has been proved recently, is at the bottom of the condenser or at the upper part of the receiver. The gas piping should be as simple and as direct as possible with the elimination of as many gasket joints as possible. Welded sleeve pipe joints will be found to save ammonia.

How To Determine the Proper Size of Chimney

By THOMAS S. CLARK

Most of the formulas for determining chimney sizes are empirical and are scattered over various books and papers. These generally give satisfactory results provided they are used within the limits of the assumptions upon which they are based, or in other words, one must have definite knowledge applicable to the specific problem. The author has here attempted to put into one article the necessary elements for determining the proper size of chimney for a given installation.

THE height and diameter of any chimney are determined by considering: First, the amount of draft required; second, the requisite and economical velocity; and third, the maximum quantity of gas that must pass out of the chimney.

The available draft is equal to the difference in the weight of the cold column of external air and a like column of hot gas in the chimney, minus the loss due to internal friction and the loss due to accelerating the gases. The height, therefore, depends upon the available draft required and may be influenced by the diameter.

The maximum theoretical draft of a chimney at sea level is given in the formula, expressed in inches of water,

$$MTD = H\left(\frac{7.64}{T} - \frac{7.95}{T_1}\right)$$

where

MTD = Maximum theoretical draft;
H = Height in feet;
T_1 = Average absolute temperature (deg. F.) of the flue gases;
T = Absolute temperature (deg. F.) of outside air.

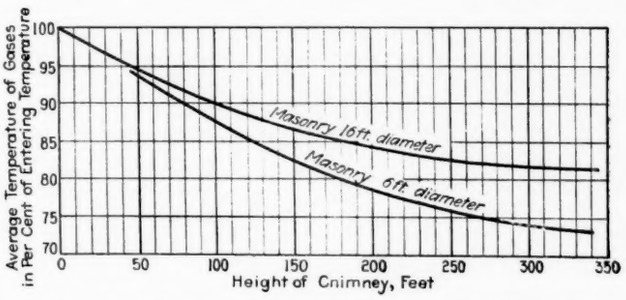
The weight of the gas that will pass up the chimney increases as the temperature of the flue gas increases, but maximum is reached according to Rankin at about 622 deg. F., as at any internal temperature above that the gas velocity increases less than the density of the gas decreases.

In the draft formula the average temperature is used because tests show that the temperature of the gases at the top of the chimney is less than it is at the bottom. The amount of drop in temperature depends upon the dimensions of the chimney, the material of which it is built and the volume of the gases. In tall chimneys of large diameter the drop in temperature is usually less than it is in tall chimneys of small diameter. In unlined steel stacks the drop is greater, especially with low external temperatures.

Unfortunately, there have not been many tests made to determine actual chimney performance, and the engineering profession is in need of further information on this subject. Facilities for observation and tests have been provided at three elevations on the chimney 225x11 ft. at Cornell University, Ithaca, N. Y., and the chimney 175x10 ft. at the Oregon Agricultural College, Corvallis, Ore., and on the chimney of the Public Service Company, Colo., 250x16 ft. The chimney 150x7 ft. at Johns Hopkins University, Baltimore, Md., is also equipped with facilities for the investigation of chimney performance.

The curves, here shown, give some results of the observations on the drop in temperature as the gases move upward in brick chimneys deduced from observation by Peabody and Miller and J. C. Smallwood.

The available draft in a well-designed chimney at the breeching opening may be safely assumed as 80 per cent



Average temperature of gases in percentage of entering temperature according to height of chimney

of the theoretical. A small number of tests on comparatively high chimneys gave results close to this value. The coefficient of friction in masonry chimneys has not been definitely ascertained.

The available draft required is determined by taking draft gage readings on installations similar to the one proposed. In the event that this is not possible, the proposed installation should be analyzed in the light of past experience and the available draft required estimated. If the chimney is located near a high hill or building, it may be necessary to increase the height because the wind may decrease the available draft when it blows from the direction of the barrier.

The required area is obtained by dividing the volume of gases emitted by the assumed velocity. With the total weight and analysis of the fuel burned and the flue-gas analysis, the total weight or volume of the flue gases can be calculated. For ordinary calculations the following velocities have been recommended. They may be safely used for the following quantities of gases without undue friction losses in the chimney or prohibitive cost of construction.

Gases, Lb. per Hour	Velocity, Ft. per Sec.
3,600	10
55,750	15
120,900	20
247,000	25
559,000	30
1,105,000	35

Chimneys at Altitudes Above Sea Level

As the altitude above sea level increases, the barometric pressure decreases, or in other words, the weight of air per cubic foot is less. There is some difference of

opinion as to the correct method for calculating the height of chimney at altitudes. However, the method commonly used of multiplying the height required at sea level by the ratio of the barometer reading at sea level to the barometer reading at altitude has given good results.

The weight of air required to burn a pound of any given fuel is the same regardless of the altitude. Therefore, it is obvious that the volume of air furnished for combustion and the resultant volume of flue gas must increase as the barometric pressure decreases.

It is evident that when the height of the chimney and volume of gas are increased, the friction loss is increased. In order that the same draft may still be available as at sea level, it will be necessary to increase the diameter proportionately. Reliable authorities state that the diameter should vary as the two-fifths power of the ratio of the barometer reading at sea level to the barometer reading at altitude.

The table has been compiled, giving the barometric pressure at different elevations, the ratio of the pressures and the value of the two-fifths power of the ratio.

CHIMNEYS AT ALTITUDES ABOVE SEA LEVEL
CORRECTION FACTORS

Altitude in Feet Above Sea Level	Barometer Reading in Inches	*R* Relative Gas Volume	*R* 2/5 Ratio Chy. Diameters	Altitude in Feet Above Sea Level	Barometer Reading in Inches	*R* Relative Gas Volume	*R* 2/5 Ratio Chy. Diameters
0	30.00	1.000	1.000	4,500	25.45	1.180	1.068
500	29.46	1.019	1.008	5,000	24.98	1.201	1.076
1,000	28.92	1.037	1.015	5,500	24.53	1.224	1.084
1,500	28.40	1.057	1.023	6,000	24.08	1.246	1.092
2,000	27.88	1.076	1.030	6,500	23.65	1.269	1.100
2,500	27.38	1.096	1.038	7,000	23.22	1.292	1.108
3,000	26.88	1.116	1.045	8,000	22.38	1.340	1.124
3,500	26.40	1.137	1.053	9,000	21.58	1.390	1.141
4,000	25.91	1.158	1.060	10,000	20.80	1.442	1.158

It is observed that the drop in barometric pressure affects the height very much more than the diameter. Up to altitudes of 2,500 ft. or 3,000 ft., although the height should be increased, no increase of diameter is necessary for practical purposes.

Where the altitudes are unusually high, the available draft required is reduced by changing the plant design, lowering the combustion rate and increasing the size of the flues. If this were not done, a very high chimney would be required to give the desired results.

Example I—To determine the size of chimney required at an elevation of 6,500 ft., assuming that a given installation requires a chimney 180x7½ ft. at sea level and the available draft required is the same.

Normal barometer at sea level = 30 in.
Barometer at 6,500 ft. = 23.65 in.
Ratio between the pressures $R = 1.269$
Height of chimney = $180 \times 1.269 = 228$ ft.
The two-fifths power of ratio of the two pressures = 1.100.
Diameter of chimney = $7.5 \times 1.100 = 8$ ft. 3 in.
Hence a chimney 228 ft. by 8 ft. 3 in. is required.

At 2,000 ft. altitude the chimney height would be $180 \times 1.076 = 194$ ft., with practically no change in diameter necessary.

Chimneys in Plants Burning Coal

The accuracy of formulas to determine stack sizes for boiler plants evolved by early authorities depended mainly upon the value of certain constants. The fixing of proper values for these constants with any degree of accuracy is almost an impossibility. Consequently, it has not been found practical to apply them generally to chimney design. For this reason many engineers have resorted to rule of thumb with results not entirely unsatisfactory, yet they may err one way or the other. The well-known and generally accepted formulas of Kent, frequently applied, accord well with the good results of actual practice, particularly when overloads are not high.

The dimensions of a chimney should not be taken from a table or calculated from a formula and be accepted as final without computing the size on a maximum gas basis and total draft loss basis, using the method previously discussed. Yet it is helpful and interesting to compare a tabulated horsepower size with one computed on the aforementioned basis.

The formulas of Kent applied to the determination of the chimney area, horsepower and height are based upon the following assumptions:

1. The draft power of the chimney varies as the square root of the height.
2. The retardation due to friction between the ascending smoke stream and the chimney walls is taken care of on the assumption that there is a layer of gas two inches thick against the walls, which has zero velocity.
3. The power varies directly as the effective area. So

$$Hp. = 3.33\,E\sqrt{H};\quad H = \left(\frac{0.3\,Hp.}{E}\right)^2;\quad E = \frac{0.3\,Hp.}{\sqrt{H}};\quad E = A - 0.6\sqrt{A}$$

where

A = Total area in square feet;
E = Effective area in square feet;
H = Height in feet;
$Hp.$ = Horsepower.[1]

The coefficient 0.6 may be used for both square and round chimneys, and in the case of the latter the diameter of the actual section.

From these formulas tables giving the boiler horsepower of chimneys were computed and are available in engineering handbooks.

The formulas and tables of Kent just discussed are based in part on the results obtained in a large number of power plants. For comparatively small installations operated at moderate ratings, they are sufficiently accurate for layouts and estimates. Mr. Kent states that the tables give the boiler horsepower the chimney will serve only when the draft losses are not excessive.

To determine the required height, the loss of draft must be ascertained, due to all causes, from the ashpit to the point where the flue enters the chimney. The maximum available draft required for a given installation may be expressed by the formula,

$MAD = LG + LI + LB + LF + LT + LE, L, etc.$

where

MAD = Maximum available draft required;
LG = Loss through the fuel bed necessary to produce the required rate of combustion;
LI = Loss to provide furnace vacuum, etc.;
LB = Loss through the boiler at the rating assumed as the maximum required;
LF = Loss through the flue;
LT = Loss due to the turns or bends in the path of the smoke stream after leaving the boiler;
LE = Loss through the economizer if used;
$L, etc.$ = Loss through any other apparatus in the path of the smoke, such as settling chambers, baffles, superheaters, etc.

[1] Refers to boiler horsepower, equivalent to 10 sq.ft. of boiler heating surface.

The draft loss in the flue or breeching depends upon its length, its cross-section, the material of which it is built and the number of bends. The smoother the inside of the flue the straighter it is, the nearer it approaches to a circle in cross-section the less the loss at a given gas velocity. Sharp right-angle bends, sudden changes in area or shape of section are to be avoided and all changes of direction made easily. If the chimney can be placed in the geographical center of the batteries of boilers, minimum lengths of flues are generally obtained.

As a rule in steel flues of circular section there will be a loss of 0.10 in. per 100 ft. of length with normal gas velocities. Each right-angle bend represents a loss of 0.05 in. If the flues are square or rectangular, there will be an average additional loss ranging up to 25 per cent. The loss increases as the ratio of height to width increases. If the flues are built of masonry, there will be a further loss unless the walls are smooth.

The loss of draft through the boiler itself—that is, from the top of the fire to the point where the gases leave the boiler and enter the flues—depends upon a number of factors and varies widely. The factors are the size and type, the number of tubes and the way they are set, the type of grate, the method of baffling, and rating at which the boilers are operated. This loss may vary 0.15 in. or 0.25 in. at rating, to 0.80 in. or 0.85 in. for a maximum of 250 per cent or more rating. It is advisable for the engineer to co-operate with the boiler manufacturer in determining the loss of draft to be assumed through the particular type and setting of boiler at the maximum rating required.

With natural draft stokers and hand-fired furnaces there is an additional loss through the fuel bed, dependent upon its thickness, the kind of fuel and the type of grate. There is a certain draft over the fuel bed that will give the best results for every combustion rate and kind of fuel. Again, it is advisable for the engineer to co-operate with the boiler and stoker manufacturer in determining the loss of draft to be assumed through the fuel in order to produce the best results from a specific fuel and type of boiler fired at the desired ratings.

Requirements with Forced-Draft Stokers

With the forced-draft type of stoker the requirement is somewhat different, for the reason that the air is forced by fans through the fuel bed, relieving the chimney of this duty. It is considered good practice to allow 0.05 to 0.15 in. draft over the fire in forced-draft installations to prevent the formation of positive pressures in the furnace. If this allowance is not made, there is a possibility of overheating the furnaces and fronts; also there is the possibility of objectionable gases being forced out into the boiler room.

If economizers are used between the boilers and chimney, there is an additional loss in draft, due to friction through the economizer. This friction loss varies within wide limits, depending upon the type of economizer, the number of tubes and the length and the velocity of the gases passing between the tubes. The heat absorbed by the economizer is dependent upon the gas velocity. The economizer reduces the temperature of the flue gases. This reduces materially the available draft, or in other words affects the required height of chimney.

With low stack temperatures and economizers, to depend upon natural draft alone would require a ridiculously high chimney, especially with boilers operated at high ratings. In this case the best modern practice, where overloads from 200 per cent to 250 per cent or more are contemplated, is to provide a chimney of ample height and diameter to operate the boilers when the economizers are cut out; then to provide induced-draft fans to furnish the additional draft needed with the economizers in service.

Mistakes have been made in the past by trying to reduce the chimney heights in such cases. This resulted in the sluggish movement of gases through the boilers and economizers, with inefficient and incomplete burning of the coal and disappointing results as to capacity. Therefore, to meet heavy peak loads with economizers the chimney should be of ample height supplemented with induced-draft fans to overcome all the previously cited losses, so that there is a constant flow of gases from the ashpit to chimney.

Where many boilers are connected to one chimney, the temperature and quantity of flue gas depends upon the number of boilers in service and the ratings at which they are operated. Therefore, the available draft varies. Accordingly, when a few boilers are operated at high ratings to carry the load, the flue-gas temperatures are higher and the available draft is increased. On the other hand, operating a majority of the boilers at low ratings decreases the temperatures and the draft falls off. The varied conditions expected should be studied to determine the proper size of chimney and whether more than one chimney should be installed.

Operating Results Should Govern

The economy and efficiency of operation during the life of the plant, rather than first cost, should be given due weight in making this decision. It may be that property limits will restrict the available space so that there is only one solution of the problem.

Chimneys ranging from 275 ft. to 350 ft. high, with diameters in proportion, are economically and successfully operated in many large power plants.

It will be noted that an outside air temperature of 60 deg. F. has been assumed in making the draft calculations. In northern climates, for months, the temperatures are often below freezing and there are periods when the temperatures are far below 0 deg. F., while in summer the temperature may be above 90 deg. F. The available draft is greater in winter and may vary 75 per cent throughout the year. In selecting a chimney size, due allowance should be made for the most adverse atmospheric conditions. These occur when the outside air temperatures are highest and the barometer lowest.

When designing a chimney to serve a heating plant located in northern latitudes, it is customary to assume that the temperature of the outside air will be somewhat less than 60 deg. F. However, it is wise to be conservative in reducing stack heights and to recommend ample dimensions where there is any doubt. The boiler cannot be operated efficiently or at high ratings unless the chimney is properly proportioned. Many power-plant owners have saved thousands of dollars and avoided embarrassment by having ample stack height and capacity. It is impossible to predict the quality of coal that can be secured at all times or when a stoker or boiler will require repairs or overhauling. *There is a reserve in every unit of a well-designed power plant, its stokers, its boilers, its pumps, its*

engines or turbines, and that principle should be carried straight through to the chimney. If not, the reserves back of the chimney will fall short of their purpose.

Each installation is a study of its own. The important problem is the determination of the available draft required at the point where the flue enters the chimney, giving careful consideration to the draft losses through all the equipment. Practical experience, good judgment and a study of the equipment are required for each installation and no one can lay down fixed rules to apply to all cases. The diameter of a chimney is determined on a gas basis as previously described.

Chimneys in Plants Burning Oil

The sizes of chimneys to be used where fuel oil is burned are determined in the same way as when coal is used as fuel. For several reasons calculations will result in a chimney of less height and smaller diameter.

There is no fuel-bed loss; in fact some types of burners have a certain forced-draft action.

Less weight of air per square foot of boiler-heating surface is required; consequently, the pressure drop through the boiler and flues is less than when coal is burned. Some reduction in the height of the chimney is, therefore, permissible, but it should be borne in mind that the flue-gas temperatures are lower when oil is burned, thus reducing the available draft. The height should be sufficient to furnish the draft required at peak loads and no more. This is much more important in the burning of oil than in the burning of coal. In the latter case there is little or no danger of too much draft.

In the former great loss in economy may result from excessive draft during the periods of light load. This is especially true in a plant operating with a fluctuating boiler load. Automatic control does much to eliminate this evil. It permits the proper height to be used without undue losses. This is as it should be. Always determine the height of chimney for maximum boiler requirements.

Several authorities state that good results are obtained by reducing the area from 35 to 45 per cent below that required for coal burning. This is merely an arbitrary assumption. Such a method is not recommended. The diameter is dependent entirely upon the volume of gases to be moved at a given velocity. This volume is dependent upon the calorific value, the composition and amount of the oil burned together with the percentage of excess air. Some boiler manufacturers give tables of chimney sizes suitable for various oil-fired boiler plants. They are useful only as a check after the size has been determined by the method previously described.

In proportioning chimneys for oil-fired furnaces, consideration should be given to the possibility of having to turn to coal for fuel, due to scarcity and price of oil.

Example II—Determine the height and diameter of a circular masonry chimney for the following conditions:

Water-tube boilers, hand-fired, builder's rating 1,500 hp. (15,000 sq.ft.), burning Virginia semi-bituminous coal, calorific value 13,000 B.t.u., boiler rated at 10 sq.ft. heating surface, ratio of heating surface to grate surface 50 to 1, length of circular steel breeching 40 ft., 2 right-angle bends, outside air 60 deg. F., average internal stack temperature 580 deg. F., location sea level, boilers operated at a maximum of 150 per cent rating.

With this equipment, a combined efficiency of 65 per cent may reasonably be assumed.

Unit of evaporation = 970.4 B.t.u.

One boiler horsepower is equivalent to $34.5 \times 970.4 = 33{,}479$ B.t.u.

Pounds of coal burned per boiler horsepower-hour (10 sq.ft. heating surface) $\frac{33{,}479}{13{,}000 \times 0.65} = 3.93$.

Square feet of grate surface $\frac{1{,}500 \times 10}{50} = 300$.

Pounds coal burned per hour $2{,}250 \times 3.93 = 8{,}843$.

Pounds of coal burned per square foot grate surface $\frac{8{,}843}{300} = 29.48$.

Summing the draft losses up, we have:

Loss through fires and grates, in.	0.40
Loss through boiler, depending upon type and setting, in.	0.45
Loss in steel flue circular section, 70 ft. (0.10 in. per 100 ft.), in.	0.07
Loss in two right-angle turns, in.	0.10
Total, in.	1.02

$$\text{Theoretical draft required} = \frac{1.02}{0.80} = 1.275 \text{ in.}$$

$$1.275 = \left(\frac{7.64}{521} - \frac{7.94}{1{,}021}\right) H$$

$$H = 187 \text{ ft.}$$

To determine the diameter: Our assumption was that Virginia semi-bituminous coal was to be burned. Pounds of air required per 10,000 B.t.u. (U. S. Bureau of Mines) = 7.6.

$$\text{Pounds of air per pound of coal} = 7.6 \left(\frac{13{,}000}{10{,}000}\right) = 9.88.$$

Assume an allowance for excess air of 90 per cent to provide against possible holes in fire, defective settings, leakage and adverse conditions, giving 19 lb. of air per pound of coal.

The total weight of coal burned per hour = 8,843 lb.

The total weight of flue gas per hour = $20.0 \times 8{,}843 = 176{,}860$.

Weight of flue gas per second = 49.1 lb.

Density of gases at 580 deg. F. = 0.0410 lb. per cu.ft. 1,197 cu.ft.

$$\text{Total volume of flue gases per second} = \frac{49.1}{0.0410} = 1{,}197 \text{ cu.ft.}$$

Assume that the economical velocity is 22.5 ft. per sec.

$$\text{The minimum effective area required} = \frac{1{,}197}{22.5} = 53.2 \text{ sq.ft.}$$

The minimum diameter required = 8 ft. 3 in.

On the assumed premises select a chimney 187 ft. by 8 ft. 3 in.

Referring to any table of chimney sizes, it will be seen that there are several chimney sizes given as capable of serving a 15,000-sq.ft. boiler.

If any chimney size were selected which has a height appreciably less than 187 ft., it would be impossible to operate the boiler at 150 per cent of rating, and if the height were appreciably more than 187 ft., the chimney would not be of the most economical dimensions for this particular case.

It is, therefore, evident that the only safe method to employ is to compute the height and diameter in accordance with the principles laid down in the sample problems heretofore given and to ignore all tables and formulas.

Example III—Assume the same conditions as before

except that the boilers are operated at 200 per cent of rating with forced draft stokers. Determine the height and diameter of the required chimney.

The draft required through the fuel bed is taken care of by the fans with forced-draft stokers.

The volume of gas formed per second will increase as the forcing increases. Consequently the draft loss through the boiler increases.

Summing up the draft losses we have:

Initial draft over fires for furnace, vacuum, etc.	0.10
Loss through boiler at 200 per cent rating, depending upon type of boiler settings, baffling, etc.	0.70
Loss through flue (as before)	0.07
Loss in two right-angle bends	0.10
Total	0.97

Theoretical draft required $= \frac{0.97}{0.80} = 1.21$ in.

At 200 per cent rating assume the average temperature in the chimney to be 580 deg. F. with outside air 60 deg. F.

$$1.21 = \left(\frac{7.64}{521} - \frac{7.95}{1{,}043} \right) H$$

$$H = 173 \text{ ft.}$$

An assumption of a combined efficiency of 70 per cent is reasonable.

Pounds of coal burned per boiler hp. (10 sq.ft.) per hour $= \frac{33{,}479}{13{,}000 \times 0.70} = 3.68$.

Pounds of coal burned per hour $= 3{,}000 \times 3.68 = 11{,}040$.

With forced draft stokers it is usually safe to assume 18 lb. of air per pound of coal burned.

Total weight of flue gas per hour $= 19 \times 11{,}040 = 209{,}000$ lb.

Weight of flue gas per second $= 58.3$ lb.

Density of gases at 580 deg. F. $= 0.040$ lb. per cu.ft.

Total volume of gases per second $= \frac{58.3}{0.04} = 1{,}457.5$ cu.ft.

Assume that the economical velocity is 24 ft. per sec.

The minimum effective area required $= \frac{1{,}457.5}{24} = 60.8$ sq.ft.

The minimum diameter required $= 8$ ft. 10 in.

On the assumed premises select a chimney 173 ft. by 8 ft. 10 in.

The height is less, as it is not necessary for the chimney to furnish the draft for drawing the air through the fuel bed.

The draft loss through the boiler plus the draft loss for furnace vacuum is less than the loss was through the boiler and grates in the case of hand firing.

The height of chimney calculated in the examples is the net height, or that measured above the boiler damper. If the breeching is level, the height will, of course, be measured from the point where the breeching enters the chimney. The total height of the chimney will be the net height plus the distance from the datum point to the top of the chimney foundation.

Northeast Superpower Studies Completed

Report Covers the Present and Future Power Requirements of the Ten Northeastern States and Part of Ohio, Virginia and West Virginia

IN OCTOBER of last year Secretary Herbert Hoover, with the consent of the President, held an informal conference with the chairmen of the State Utility Commissions of the eleven Northeastern States and had a preliminary discussion of the steps that might properly be taken by federal and state authorities in the promotion of superpower development in the Northeastern States, as reported in *Power*, page 667, Oct. 23. As an outcome of this conference the Northeastern Superpower Committee was formed. The Governors of the several states appointed members representative of the Utility Commission or of such other official agencies as had a direct relationship to the question. The United States Geological Survey, Federal Power Commission and United States Army also designated members. This committee has recently submitted its report from which the following is abstracted.

The region covered by the report comprises one of several power areas into which the United States naturally divides itself and is indicated by the maps Figs. 3 to 6. In this area is concentrated 40 per cent of the country's population, which consumes 50 per cent of the kilowatt-hour production and operates 60 per cent of the primary power of the country. A study of the power requirements in the so-called primary states, Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland and the District of Columbia, shows that there was produced 21,200,000,000 kw.-hr. of electrical energy in 1922, of which 25 per cent was produced by waterwheel driven generators. There is in addition approximately 10,600,000 hp. (equal to approximately 13,900,000,000 kw.-hr.) of mechanical power used in industry, not including railroad transportation, which could to some extent be advantageously replaced by electric power.

About 84 per cent of the total electrical power consumed in the primary states, or 17,750,000,000 kw.-hr., is consumed at the load centers, indicated in Fig. 1, with the exception of the Cleveland-Akron-Youngstown district, which is ouside of the primary states in the region investigated. The latter used 2,000,000,000 kw.-hr. more. A study of the growth of electric power applications shows that it has compounded for the last ten years at the rate of 10 per cent per annum. An approximation of the future demand, not including possible electrification of railways, indicates the total electrical power demand in 1930 to be 30,800,000,000 kw.-hr. The demands at the important load centers are indicated in Fig. 1.

The demand for electrical power within this area is supplied from water and fuel. The present developed water power is about 3,036,000 hp., the total potential water power available 90 per cent of the time is 5,426,000 hp. and for 50 per cent of the time 7,914,000 hp. The geographical locations of the coal fields and of developed and undeveloped water power are shown in Fig. 3. The production and transmission costs of power are shown in Figs. 2 and 5.

The economic generation and distribution of power

requires that it be produced in large plants. Present practice indicates that such plants should be constructed with total capacities ranging from 200,000 to 500,000 kw., using generators of not less than 20,000-kw. capacity. Since one of the important controlling factors in the location of such plants is the condensing water, their

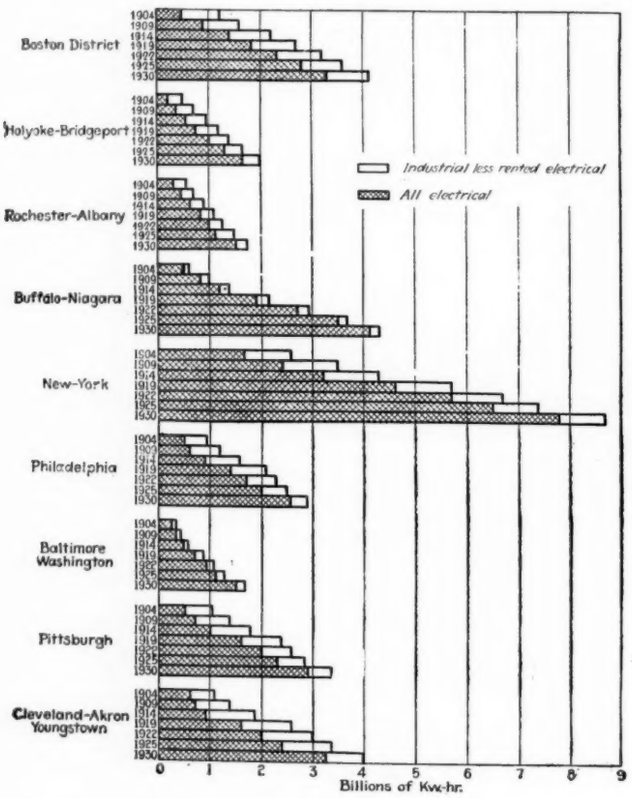


Fig. 1—Power consumption at load centers 1904 to 1930

construction will be limited to areas along the seaboard, the Great Lakes, Ohio River and its tributaries and the Susquehanna. The generation of power at the coal fields in western Pennsylvania, Ohio and West Virginia and in plants on the Ohio River and its tributaries will, according to the report, become an important factor in a large area because of the savings in coal transportation. This problem as it affects the coastal area becomes one of relative costs of electrical power transmission and of coal transportation. Some difference of opinion exists as to the distance power generated at the coal fields can be advantageously transmitted.

There are in this area nearly two hundred different utility companies engaged in power production and distribution, many under common ownership. Of these about 45 per cent are technically interconnected, but only about 8 per cent of the interconnections have capacity large enough for effective interchange of power. Great economies in cost of production can be secured from the early effective interconnection of these utility systems, in some cases involving larger and systematic high-voltage transmission.

Such interconnection, according to the committee will lead to the reduction of the amount of reserve equipment, better average load factor through pooling of daily and seasonal load variation and wide diversification of use through increased industrial consumption, and more security in power supply against interruption by many causes. It will also mean that available water power in the area can be much more advantageously applied to carry base or peak load as local conditions may require. It should make possible the use of secondary water power which arises from the seasonal flow of streams, and thus bring into practical use a larger quantity of water power than would otherwise be possible. Finally, power would be available more quickly to meet growing demands.

Interconnection in some cases will convert secondary hydro power into primary power and in other cases will enable daily peak loads to be carried on hydro. The great water powers capable of expansion, according to the report, are: The Niagara River, the St. Lawrence River, the Delaware River, the Susquehanna River, the tributaries of the upper Ohio, the rivers of the Adirondacks, the Potomac River and the rivers of Maine.

In the area covered by the report the large demand for power and the opportunity to replace more expensive steam generation in many localities affords an immediate market for the cheap water power from the larger water-power projects and renders their development, in the opinion of the committee, both urgent and necessary.

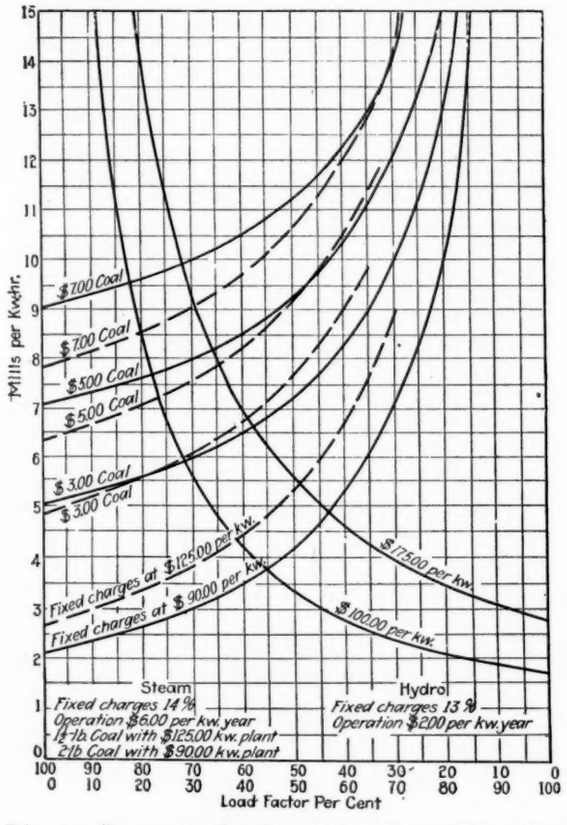


Fig. 2—Power-production cost curves from steam-electric and hydro-electric plants

In this area the large use of steam renders possible the use of seasonal flow of rivers for relief of steam, and this enables more complete utilization of the rivers than in any other part of the country. The amount of the total power demand that can be supplied in 1935 by water power in different districts in the area covered by the report is indicated in Fig. 4. The cost of power in different sections of this area is also indicated in this

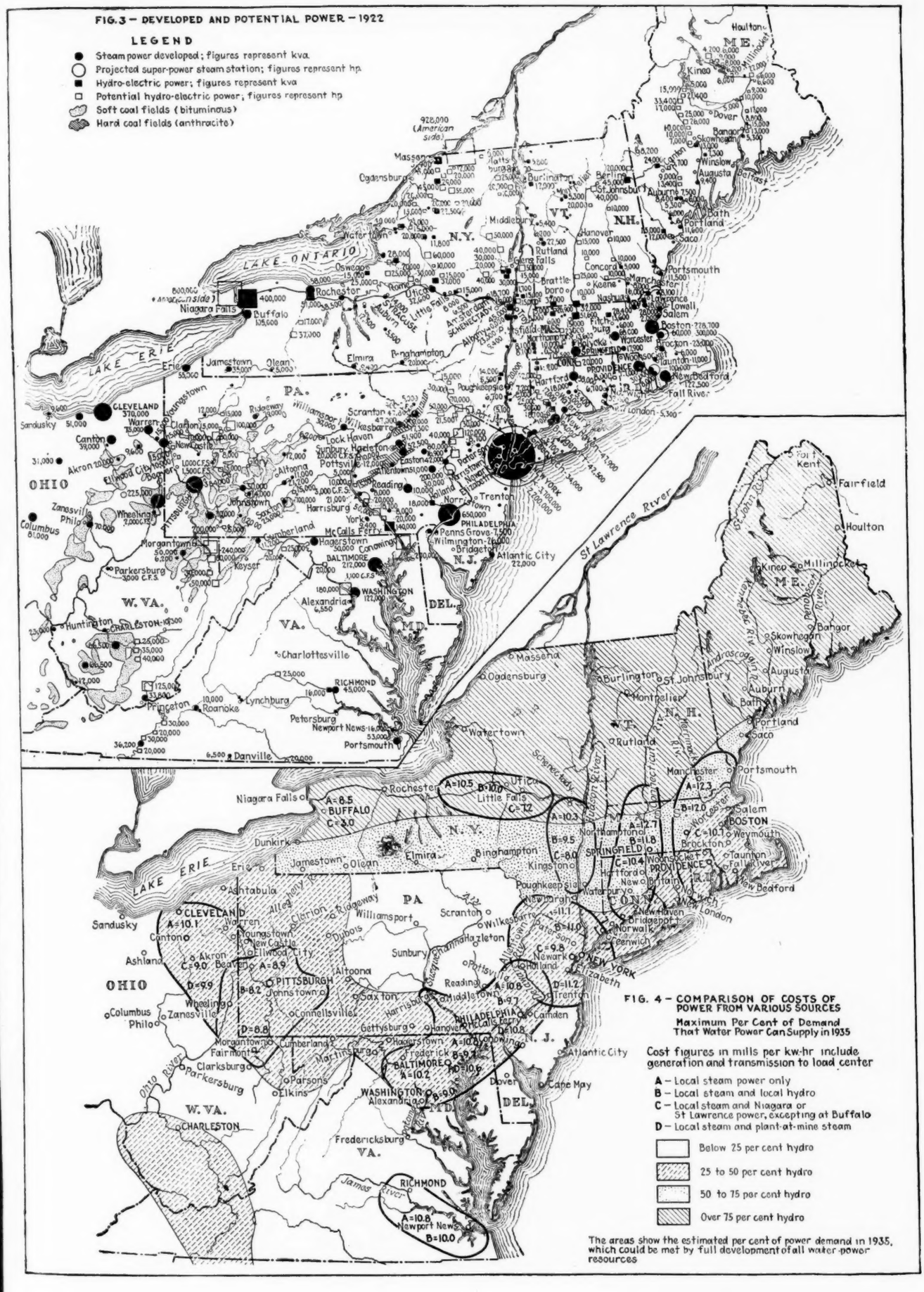


FIG. 3 – DEVELOPED AND POTENTIAL POWER – 1922
LEGEND
Steam power developed; figures represent kva.
Projected super-power steam station; figures represent hp.
Hydro-electric power; figures represent kva
Potential hydro-electric power; figures represent hp
Soft coal fields (bituminous)
Hard coal fields (anthracite)
LAKE ONTARIO
LAKE ERIE
OHIO
PA.
N.Y.
VT.
N.H.
ME.
W. VA.
VA.
MD.
DEL.
N.J.
CONN.
R.I.
MASS.
Niagara Falls
Buffalo
Rochester
Utica
Syracuse
Albany
Schenectady
Troy
Boston
Providence
New York
Philadelphia
Pittsburgh
Cleveland
Columbus
Wheeling
Charleston
Baltimore
Washington
Richmond
Newport News
Norfolk
St Lawrence River
Ottawa River
Hudson River
Connecticut River
Androscoggin R.
Kennebec River
Penobscot River
St John R.
FIG. 4 – COMPARISON OF COSTS OF POWER FROM VARIOUS SOURCES
Maximum Per Cent of Demand That Water Power Can Supply in 1935
Cost figures in mills per kw-hr include generation and transmission to load center
A – Local steam power only
B – Local steam and local hydro
C – Local steam and Niagara or St Lawrence power, excepting at Buffalo
D – Local steam and plant-at-mine steam
Below 25 per cent hydro
25 to 50 per cent hydro
50 to 75 per cent hydro
Over 75 per cent hydro
The areas show the estimated per cent of power demand in 1935, which could be met by full development of all water-power resources

figure. In general the lowest cost for power in the area will be found to be around Buffalo and Niagara Falls and the highest in the vicinity of Boston. The conclu-

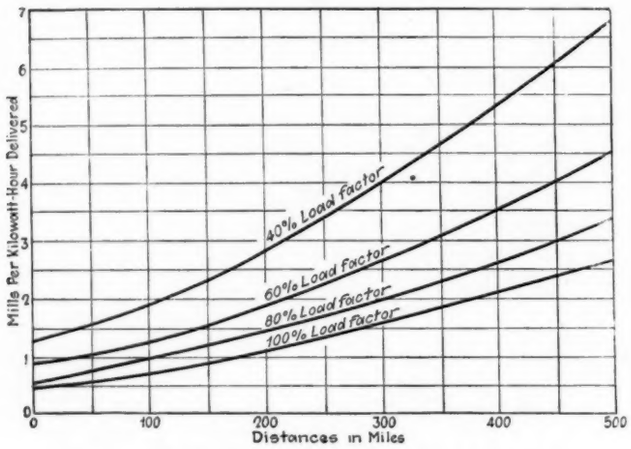


Fig. 5—Transmission cost based on 75 per cent capacity factor

sions reached by the committee are that the economical and adequate power supplies for this area require:

A. Extension of interconnection between systems.

B. The building of large centralized steam-electric plants located at strategic points.

C. The development of the large hydro-electric projects.

The economic values of such developments are:

1. An estimated reduction of coal consumption by over 50,000,000 tons annually.
2. More economical production of power.
3. Security in power supplies against interruption with its losses through disturbed production and unemployment.
4. Larger reserves of power through which other industrial development need not lag, awaiting power construction.
5. Electrification of transportation with increase in its efficiency.
6. Extension of power uses to the farm.
7. Decrease in human labor.

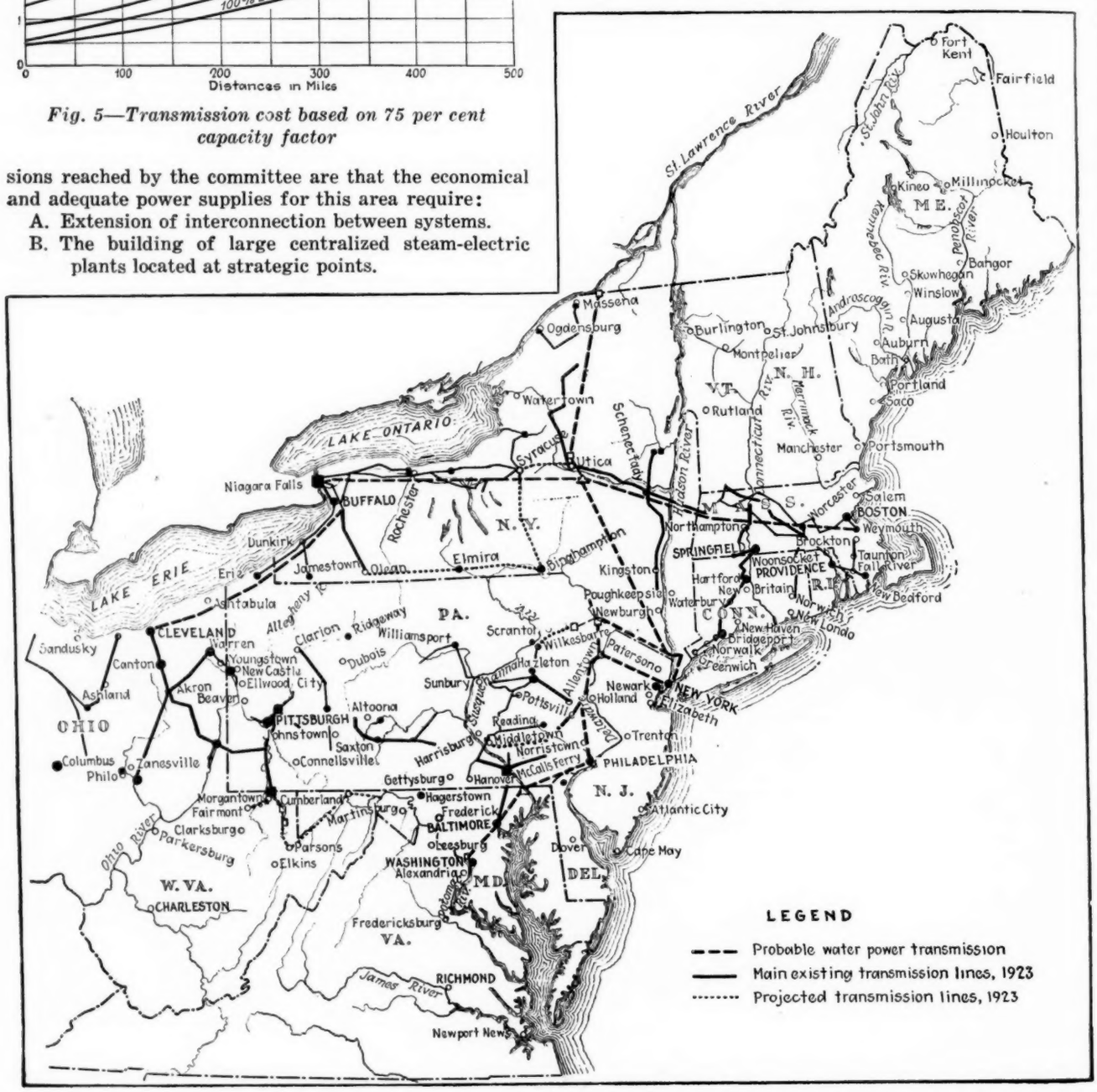
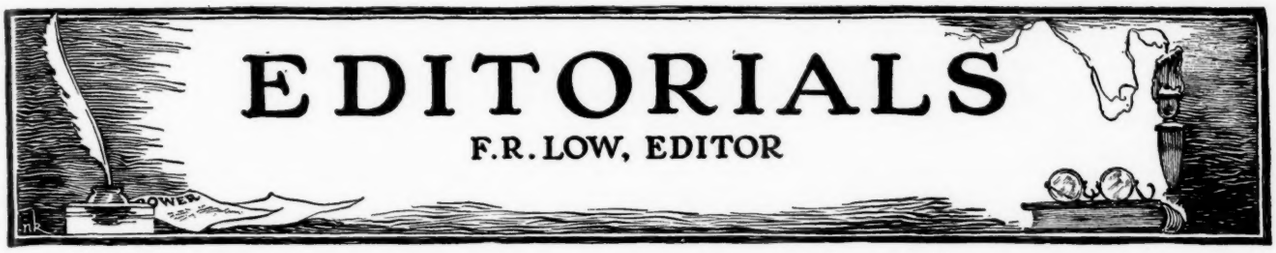


Fig. 6—Heavy full lines show existing main transmission lines and the heavy dash lines new line that will be necessary to bring power from possible cheap sources to large load centers

There are many other small capacity transmission systems inthis area which are not shown on this map.



The World Power Conference

MANY international congresses have been held in the past, covering various phases of human relations and endeavor; but the World Power Conference, which has just concluded its sessions at Wembley, is the first to be dedicated to power as a dominant force in the world's productive capacity and social progress.

It will indeed be difficult to assess in tangible form the net results of the meeting. From an economic point of view it furnished a better understanding of how the different nations are handling the development of their natural resources of fuel and water power and the regulative policies employed. Moreover, the data forming a permanent record, will serve as an index of the wealth of these countries, measured in potential or actual industrial activities.

While it is true that from a strictly technical viewpoint few of the papers disclosed much that was not already known in certain well-informed circles, they nevertheless did show that, regardless of nationality, engineers appear to be grappling with kindred problems, especially in the employment of higher pressures and other measures aimed at increased economy in power production. Perhaps most important of all, the Conference afforded an opportunity for these men to become personally acquainted and to exchange experiences both in and out of the meeting hall, thus establishing a point of contact which many will utilize to advantage in future exchanges of ideas.

It is gratifying that steps have been taken to form a permanent international committee with the idea of holding future conferences of this character as time and occasion may dictate. In this connection, however, it may not be amiss to warn against holding such meetings at too frequent intervals lest they become perfunctory; possibly every five years would give sufficient time to take stock of the advances in the art of power production.

British Plan for Coal Regulation

THE recommendations of Lloyd George's Committee for improvement of conditions in the coal industry in England are of interest to American readers in the light of comparison with suggestions made by our Federal Coal Commission last Fall. Both commissions go on record as unequivocally opposed to nationalization of the mines, although advocating a measure of regulation. The American Commission would bring this about largely through publicity of production costs, whereas the weapon of the British regulatory body would be the administration of royalties, it being proposed that the government purchase the royalties from the present owners and lease these under conditions that would best serve the public welfare.

Similar references will be found in both reports as to the evils of over-development, the desirability of unification with a view to eliminating the high-cost, non-productive mines and the need for better housing conditions for the miner.

In the matter of co-operation between operator and miner the British would set up a Mining Council and district boards having equal representation of workers and owners, with statutory powers to deal with wages and welfare matters.

It is to be hoped that the recommendations of Mr. Lloyd George's Commission will bear fruit and be taken more seriously than those of our own commission, which thus far have been ignored by Congress and will probably remain pigeon-holed until the public finds itself face to face with another coal crisis.

Another Superpower Report

DURING last year construction work was completed or started on power projects of ten thousand kilowatts and above in this country, amounting to over five million kilowatts. Power generated and sold by the central stations alone in 1923 amounted to over forty-four million kilowatt-hours. With power consumption compounding at the rate of about ten per cent per year, as it has done during recent years, our power requirements double about every seven years. Taking the present power consumption and looking ahead ten years, which is a very short period, at the present rate of increase, the demand at that time will reach over one hundred and ten billion kilowatt-hours. The prospects are that the rate of increase in power consumption will be accelerated rather than diminished. Little wonder then that this problem is receiving so much attention at the present time and that comprehensive studies are being made of the power requirements for the different sections of the country.

In this issue is published an abstract of the report, "Superpower Studies of the Northeastern Section of the United States," which has recently been completed. These studies were started by Secretary Hoover, co-operating with the public-utility commissioners of these states and others interested, in an endeavor to promote a higher degree of interconnection between the various power systems in the states and also to obtain a more economic use of the available power sources. Although this report does not embrace exhaustive studies such as the Murray Superpower report completed in 1920, it does cover considerably more territory and has correlated the published and unpublished information on the power requirements and power resources available for the eleven states. The importance of such a study in this region can be appreciated from the fact that forty per cent of the country's population is concentrated here and uses over fifty per cent of the national power production.

In these eleven states there are nearly two hundred utility companies engaged in power production. If these companies are to go forward and expand their

power generating and distribution facilities intelligently and in a way that will best meet the needs of the future, they must have before them a comprehensive picture of not only their own territory, but that surrounding them and the sources from which power may be drawn and the cost of its delivery into the the system. It is recognized that the production and distribution of power can no longer be confined within even state boundaries; in fact, it has reached beyond international boundaries. Consequently, if the problem is to be met along the most economical lines, it must be considered on such dimensions. In this respect the report lays before the power companies and other interested bodies of the Northeastern States the electrical situation, the undeveloped potential power source of future electrical energy and the probable demands which will exist ten years hence.

Training the Operator To Meet the Emergency

THE handling of emergency situations, whether of an electrical or mechanical nature, is a vastly different field of operation from that of the regular routine work. The latter is looked upon in some instances as a monotonous daily grind, while in others perhaps as a continuous and absorbing conflict in order to maintain efficiency, complete repairs, or secure the proper distribution of load, voltage, and wattless current in a complicated system. Emergency conditions in many instances are of such a character that proper attention to and execution of routine work would have obviated their presence.

For handling such situations men specially fitted by experience may be easily available in a territory close to the engineering and construction headquarters, while on the other hand the operator of an outlying substation may be required to cope with all conditions, both usual and otherwise. In training men, there is, therefore, the type which perhaps specializes in work of a character requiring the ability to meet unexpected difficulties and, at the other extreme, men who are accustomed only to routine operation and to whom unusual conditions are perhaps beyond their sphere of activity or undeveloped ability.

As to educating the former class, little need be said. Where every-day duties require the exercising of the faculties in solving such problems, additional training along these lines is hardly necessary or advisable.

On the other hand, routine work frequently tends to become monotonous, especially where there is much spare time or long periods with little required on the part of the operator. An additional education of almost any character is of advantage. Few better instances of suitable training could be given than that instituted by a large power company, wherein the operating force is made to study possible or hypothetical conditions and to determine the best courses of action to pursue. From an educational point of view, it gives the operator an opportunity of judging his own shortcomings, as to both theory and practical judgment. It also may bring to light possible solutions that might have escaped official consideration and therefore tend to perfect and stabilize methods of handling them.

Another advantage is that it gives an opportunity to promote closer relations between the employees and the management. The man who is detached by virtue of geographical position may nevertheless find himself in close touch with those higher up, as a result of his own co-operation or ability. From the fact that extension of the human relationship is such an important element in the success of large organizations, a method of this kind is worth consideration.

It should not be lost sight of, also, that special training, even for routine work, is necessary only in so far as it fits the individual condition. Circumstances often occur where those of the requisite all-around experience are easily obtainable for routine work so that unusual conditions would not involve any question as to adequate discharge of their duties. In many plants, for instance, those experienced in marine engineering or electrical construction are glad to accept routine work as an alternative to traveling, etc. The value of unity in an organization, however, would suggest that individuals of this kind might be used to advantage as sources for advice or suggestion, thus securing an interested co-operation which would not be possible by supplying instruction where it would be distinctly unnecessary.

Ways To Save Energy

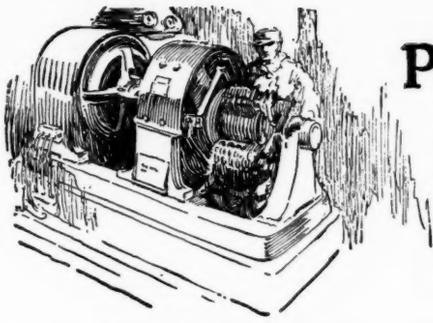
THE paper, "Reciprocal Utilization of Waste Energy," presented at the World Power Conference by B. M. Gerbel, vice-president of the Chamber of Civil Engineers of Vienna is illuminating in its suggestions. No engineer can make a general study of the question of power and energy without being impressed with the fact that the combinations are limitless. Some of these suggestions may somehow strike one as funny because of their strangeness, but they should all be judged strictly on their merits. It should be remembered that the umbrella, in its day, was laughed out of court as funny.

Such a suggestion is B. M. Gerbel's that huge hothouses be erected near central stations to utilize the energy of bled steam for the raising of early vegetables. The combination of hothouse and central station may seem incongruous, and possibly the suggestion is of no value, but that certainly cannot be determined offhand. While there are evident limitations imposed by the cost of available land, nearness of market, the cost of steam and overhead as compared with the additional value of the early vegetables etc., it is conceivable that there might be certain situations where such a proposition would pay.

Again, as emphasized by Mr. Gerbel, there are immense possibilities for the reciprocal utilization of waste energy. Of two plants situated close together, one may need a lot of power with little heat and the other a lot of heat but little power. The transfer of excess power may result in a big saving for both plants. Plants whose heating loads far exceed their power loads may in certain cases arrange with local utility companies to purchase any excess of power over requirements.

The possibility of using waste heat from central stations for warming homes, offices and factories is generally known to engineers, but little has been done along this line. In this connection the possibilities of hot-water transmission, as well as steam, should be considered.

Many of these ideas, which are intrinsically far more conservative than the mercury turbine of Mr. Emmet, are standing idle for the lack of similar dynamic personalities to back them.



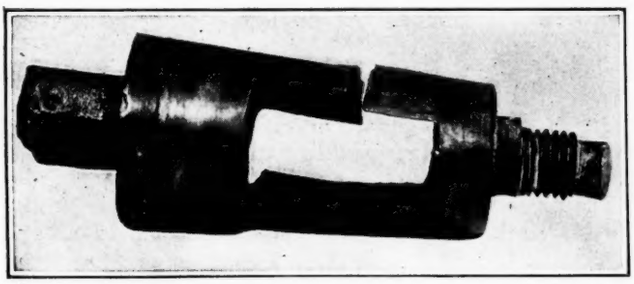
Practical Ideas *from* Practical Men

Why the Plug Should Not Be Held from the Small End

Quite often, when inspecting boilers I find the blowoff fitted with an old cock the plug of which is held in place with a nut and washer at the lower or small end.

When the engineer or owner is told that this is not good practice and contrary to the requirements of most all boiler codes, which say, "A bottom blowoff cock shall have the plug held in place by a guard or gland," he will most always say, "Why?" The illustration herewith shows clearly one of the reasons why.

The plug is out of a 2-in. cock that was placed on the blowoff of a boiler allowed 120 lb. working pressure,



How the plug failed

while the regular valve was being repaired. When the engineer tried to blow down the boiler, the plug failed as shown in the cut and the engineer was laid up for some weeks with a badly scalded leg and side.

Chicago, Ill. FRANK C. ANDERSON, Inspector, Royal Indemnity Co.

Points of Difference in Stationary and Marine Engineering Practice

The operating conditions in a marine power plant are usually more severe than those in a stationary plant. There is, for example, always a possibility of salt water leaking from the cooling-water side into the steam side of the condenser and being carried with the feed water into the boiler, where it is likely to cause priming, which may result in cracked cylinder heads or similar damage. Salty feed water also promotes leaks around the boiler-tube ends.

Reliability is the first and most important requirement of all engines and apparatus used on shipboard. The marine engineer cannot order spare parts from the engine manufacturer, as could a stationary engineer, but must often rely on the ingenuity of himself and his assistants to improvise means of putting the plant in operation again.

Simplicity and ease of operation are also very important, especially since the personnel changes frequently, and the engineer cannot always take time, before leaving port, to instruct his new crew as to the best way of operating each piece of machinery. Until they have become familiar with the operation of the plant, mistakes, which might injure more complicated apparatus, are liable to occur.

While over-all efficiency is important, it must be sacrificed to some extent, where it would reduce the reliability and simplicity of the plant. The engineer and his crew therefore pay particular attention to keeping the plant in good mechanical condition, and usually there is little time for checking and improving its efficiency. Recently, some of the larger passenger steamers have used the Orsat apparatus to check boiler and furnace efficiency, but this has not yet come into general use.

In view of what has already been said concerning the operating conditions encountered at sea, it is not surprising that the marine engineer looks askance at any machinery and devices that appear to be fairly new and untried.

One of the objections raised against the use of water-tube boilers is their inability to stand the use of salty feed water. I have seen salt depending like large icicles from handhole cover joints of water-tube boilers that happened to use salty water, due to a leaky condenser.

A Scotch marine boiler is not much affected by using salty feed water, and for this reason still finds favor among a great many marine engineers. However, the water-tube boiler has many advantages, such as quicker steaming, less weight for the same output, decreased danger from explosions, etc., so that it is in quite general use, especially on new and large ships, and almost exclusively in the Navy.

It may be of interest to some stationary engineers to know that cylinder lubrication is dispensed with, in marine power plants using vertical, multiple-expansion engines. When the engine is new, a combination of graphite and cylinder oil is used as cylinder lubrication. The graphite seems to possess the property of filling the pores of the cast-iron cylinder liner and of forming a sort of graphite-metal skin on the interior surface of the liner. The friction is thus considerably reduced, and the only lubrication used is that which works its way into the cylinder from the piston rods, which are lubricated at regular intervals with a mixture of cylinder oil and graphite.

Where superheated steam is used, some sort of cylinder lubrication must be resorted to. The engineer who has operated machinery using saturated steam and no cylinder lubrication generally finds it difficult to operate and properly lubricate machinery using superheated steam. He is generally possessed of the idea that an engine using high-temperature steam requires

a high-viscosity oil for proper lubrication. This is not the case, as a high-viscosity oil carbonizes in the cylinder, thus increasing the friction and adding to the lubricating complications. Instead, a medium-bodied oil, which will atomize properly, and after atomization provide proper lubrication, should be used. It should be compounded slightly to take care of the moisture forming on the cylinder walls by the expanding steam.

I recall an instance that shows that some marine engineers are skeptical about the benefits accruing from the use of superheated steam. In this case several new ships were being built, all to be equipped with water-tube boilers, superheaters and up-to-date machinery, but the engineers who were assigned to these vessels objected so strenuously to the use of superheaters that they were never installed.

Other instances could be cited to show reasons why a marine engineer is more conservative and skeptical than his fellow engineer in a stationary plant. The foregoing description of operating practice at sea deals mainly with those ships using reciprocating engines. In several new and large ships using some form of turbine drive, it is, of course, both desirable and economical to use highly superheated steam, as no internal lubrication is required. Those ships generally have engineers of the new school, who are more familiar with present-day engineering practice and therefore have little difficulty in running the large, up-to-date plants of which they have charge. P. G. DAHL.

Chicago, Ill.

Worm Gear and Flexible Couplings Used in Stoker Drive

Some time ago we completed alterations to our boiler plant, part of which consisted of replacing two six-retort underfeed stokers of standard length with two seven-retort extra-long stokers of the same type. The addition of the one retort and the increase in length necessitated the employment of two gear boxes in place of one as formerly used on the short stokers.

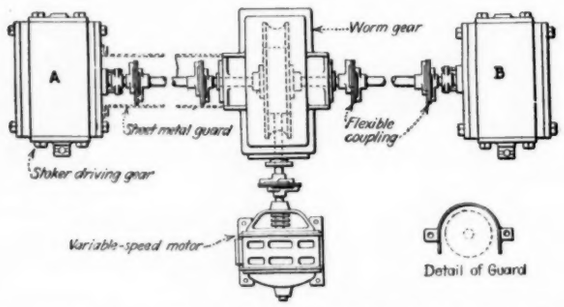


Fig. 1—Worm gear is placed between stoker gear boxes and connected to drive with flexible couplings

Not wishing to continue the use of a roller chain as a means of driving the stokers, we installed the drive shown in Fig. 1. The gear boxes *A* and *B* were placed between the first and second retorts at each end of the stoker, and a worm gear was located midway between these, as shown. The worm gear was supported by a special cast-iron bracket bolted to the bearing bracket of the stoker. The drive between the worm gear and the stoker gear boxes was with two flexible couplings and a short piece of shafting. The couplings are shown in detail in Fig. 2. The halves of the couplings were cast at a local foundry, and the machine work was done in our own shop. A similar coupling was used between the motor and the worm gear, and each section of the drive was covered with a sheet-metal guard as shown dotted in the plan and in detail Fig. 1.

The advantages of this drive over the roller chain are that it requires no external lubrication and is practically silent. G. W. BROWN.

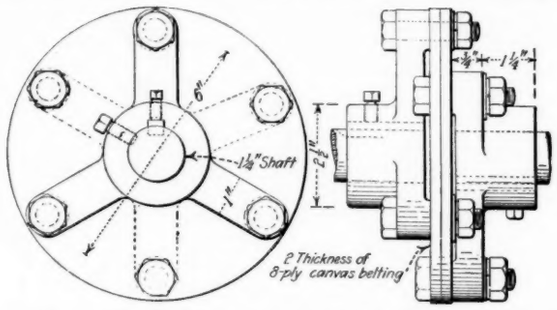


Fig. 2—Detail and assembly of flexible coupling

Cleveland, Ohio.

Taking Care of Excess Water at Hydro-Electric Plant

We have a 3,900-kw. hydro-electric plant comprised of two 1,200- and two 750-kw. generators direct connected to horizontal-shaft waterwheels. Three wheels have cylinder gates and one wicket gates and operate under 35-ft. head. The generators are 2,300-volt three-phase machines and operate in parallel on a common set of busbars.

The plant is one-half mile from the dam, water being brought to the forebay by a canal and from the forebay to the plant (400 ft.) by two 7-ft. steel penstocks to the two 1,200-kw. wheels and by two 6-ft. concrete penstocks to the two 750-kw. wheels. The penstocks are equipped with air vent pipes and a surge standpipe.

It will soon be necessary to draw off the reservoir and repair the flood gates in the dam. At such times the industrial load will be off except about 300 kw. for lighting, etc. It will be necessary to make some arrangement for handling the normal flow of the river, which is about 2,000 kw., while this work is in progress.

Is it practical to block the rotors of the generators, which is very easily done in this case, and open the gates wide on the wheels without danger of damaging the wheels, or would it be best to build a water rheostat in the tailrace of I-beams, spaced far enough apart to offer the right resistance? The load on the rheostat would be about 2,000 kw.

Any suggestions that *Power* readers may offer will be greatly appreciated. J. C. CUMMINGS

Ware Shoals, S. C.

Progress in the erection of the power plant at Filo, Ohio, of the American Gas & Electric Co., indicates that operation will be begun on Aug. 1. This will be the first central station in the country to generate power commercially with steam at 600-lb. pressure, and to employ reheating and return of the steam on a large scale. Two 35,000-kw. General Electric turbines take steam at approximately 725 deg. F., and are designed for 600-lb. pressure. An unusual feature of the fuel-supply system consists of an underwater storage for coal.

Comments from Readers

What Is Meant by the Term "Burden" in the Cost of Coal Handling?

On page 733 of the May 6 issue is a letter from C. O. Sandstrom, in which he asks for an explanation of the term "Burden," as included in the cost of coal handling.

I hasten to explain that I do not know what it is. I placed it as an item in coal-handling costs simply because it was so used in Mr. Titcomb's article, which I was discussing. My opinion is that it has no business in the cost at all.

H. E. BIRCH, Engineering Manager,
Philadelphia, Pa. R. H. Beaumont Co.

Leaky Compressor Valves

In an article entitled "Leaky Compressor Valves," in the May 13 issue, John Cassiday takes exception to a statement I made regarding the development of heated valves in air compressors as a result of leakage of air past the valves. Mr. Cassiday brings up a point that was more or less outside the scope of the article, which dealt more with the necessity for keeping out the impurities rather than with the detail of what happens in a compressor subjected to contamination by impurities. The statement that the valves become excessively heated owing to the friction of air through the restricted opening, however, is a matter that is open to question, and Mr. Cassiday has presented a very reasonable explanation, although somewhat contrary to my view of it.

Leakage past the valves is undoubtedly a throttling effect but hardly a "nozzle action." Even "throttling" is somewhat apart from a correct statement. The surfaces of leaky valves are so contaminated as to form an irregular, uneven orifice through which the high-pressure air pursues a devious course and in which the contamination offers considerable resistance. Reduced to its simplest terms, resistance to a flow of energy, whether the energy is mechanical or electrical, results in some form of "friction" which in turn results in the development of heat. There is no doubt that the temperature of leaky valves is increased by the passage of highly compressed air, due to the friction.

Whether such leaky valves become excessively heated by the passage and re-passage of compressed air is a subject that has been discussed considerably. Mr. Cassiday brings out the idea that "re-compression" of the air is the real reason for the exceptional rise in temperature sometimes experienced in compressor operation. There are several points both for and against this belief. Air that has been compressed becomes heated in proportion to the extent to which the compression is carried. The heated air, being discharged into the discharge line, carries some of this heat with it, a portion being dissipated by the water jacket. Under normal operation a complete fresh charge of air is admitted to the cylinder, which air is, of course, at suction temperature. This air, being compressed, is passed into the discharge line at the same temperature as the previous discharge. The "re-compression" theory is that when the valves leak, the air in the discharge line (usually pretty hot) leaks back into the compressor cylinder and increases the temperature of the new suction charge. This charge, being compressed, is passed into the discharge line at a temperature higher than the previous charge. The temperature of the discharge line is now higher than before. The fresh suction charge therefore receives the same amount of the air as before from the discharge line which, because it is heated to a higher degree, raises the temperature in the cylinder higher than the first charge temperature. A continuation of this process is supposed to build up the red-hot temperatures sometimes experienced, each charge of air being compressed at a higher initial temperature than the preceding charge.

There is an argument offered against this theory, and it is not possible to ignore it. It is common knowledge that in compressing air, work is done on the air and consequently a certain amount of heat is developed. On the other hand, it is equally common knowledge that, in expanding, air performs a certain amount of work and, in so doing, absorbs a certain amount of heat. The theory is that the compressed air in the discharge line, leaking back into the cylinder, naturally expands and in the process of expansion becomes cooled to such an extent that it does not materially raise the initial temperature of the fresh charge of air. This would seem to be perfectly possible in view of theory and formula. However, the fact remains that the heated air leaking back into the cylinder does not cool to the theoretical temperature. This indicates that leaky valves do influence the temperature of the compressor and very seriously, indeed.

The writer prefers to think that the expanding air would return to the cylinder at a harmless temperature if it were not for the interference of the valve and its restricted and irregular orifice, the passage through which causes the temperature of the air to remain high.

New York City. WILLIAM V. FITZGERALD.

Scale Formation in Boilers

The term "softening," which has been applied to feed-water treatment, is misleading. Those not conversant with boiler-water chemistry frequently gather that the purpose of water treatment is solely to reduce the hardness. Some believe that if the hardness is kept lower than the alkalinity as determined by titrating with methyl orange as an indicator, the formation of calcium-sulphate scale is prevented. Mr. Randall says on page 693 of the April 29 issue, that a total hardness of the feed water of 3 or 4 grains per gallon will not in nine cases out of ten produce any boiler scale. Apparently, he is of the opinion that whether or not a given feed water will produce scale depends upon the hardness of the water.

There are, of course, cases where no scale is formed with water having a hardness of 6 or 7 grains per

gallon, but in these cases the hardness is usually all temporary. There are also cases where scale is formed when the hardness is much lower than the values Mr. Randall mentions. It is my opinion that scale formation takes place in considerably more than one case out of ten where the hardness is between 3 and 4 grains per gallon.

Although the amount of scale formed depends to some extent upon the amount of hardness, as long as there is some hardness, whether or not adherent scale is formed does not depend upon the amount. The formation of scale is determined by the nature of the chemicals that are associated with the calcium and magnesium which cause the hardness. Calcium-sulphate scale can be formed from treated water having an amount of carbonate in excess of the chemical equivalent of the calcium and magnesium present. To prevent the formation of sulphate and other scales, it is usually necessary to add sufficient soda ash to cause the carbonate alkalinity to be considerably in excess of that due to the calcium carbonate present. The amount of carbonate alkalinity that must be carried depends upon the concentration of sulphate and other salt radicals in the boiler water.

Most systems of water treatment provide for a constant excess of carbonate alkalinity, but since they do not determine the amount of this excess by the condition of the boiler water, the carbonate alkalinity is sometimes not great enough in the boilers and sulphate scale is formed. To prevent scale formation with water containing much sulphate, it is necessary either to blow down frequently to reduce the concentration of sulphate in the boiler water, or to maintain a considerable carbonate alkalinity in the feed water and boilers.

Pittsburgh, Pa. J. K. CHESNEY.

Speed Regulation of Underfeed Stokers

In the July 1 issue, page 24, is a communication from J. E. Richardson, of Pittsburgh, on the subject of stoker speed regulation. Mr. Richardson refers to stoker speed regulation as a "fad." If this be a fad, it has been in active practice since the introduction of stokers, as the most important duty of the stoker operator is to regulate manually the supply of fuel to the boilers.

Mr. Richardson entirely overlooks the important element entering into stoker regulation, which is to maintain the condition of the fuel bed such that maximum economy results. When the fuel and air supply are maintained initially in their proper proportion, the condition of the fuel bed remains as it should for the combustion desired and becomes neither thick nor thin, nor does it develop holes.

No one ever expected that the rate of fuel feed to an underfeed stoker would immediately determine the percentage of CO_2, as in the case of powdered-fuel, oil or gas-fired boilers. When fuel and air are initially supplied in a proper proportion at all times, the character of combustion is maintained uniform, indirectly by the rate of fuel supply and directly through the thickness and distribution of fuel on the bed, which is the direct result of the stoker regulation.

Manual regulation of the fuel gives intermittent readjustment in the rate of fuel supply, which readjustment can be made only subsequent to a definite error, as it is only an incorrect rate of fuel supply which ever becomes apparent to the fireman. Machine fuel regulation keeps the fire continually in condition and does not give rise to an error that need be corrected by manual adjustment. The manual adjustment is a continued oscillation between too little and too much in the rate of fuel supply.

It is far easier with practical regulating apparatus to supply fuel moment by moment in proportion to the air than it is to supply fuel intermittently every fifteen or twenty minutes—not from the nature of the problem, but from the nature of regulating apparatus itself. Accurate control, which is continuous and effective every instant, is a simpler engineering proposition from the point of view of regulating apparatus than occasional correction of an error in regulation, as is done in manual adjustment.

The curves of Mr. Richardson show nothing new, as we all know that the CO_2 (and he might have added the rate of steam generation) in an underfeed stoker is not immediately dependent on the rate of coal feed, for there is always a sufficient amount of fuel in any well-conditioned bed to carry the load with good combustion for a considerable period of time. The very nature of the curves shows that prior to the tests the fires being tested were carefully regulated for a sufficient time to get them into excellent condition before the tests began.

The favorable combustion during the test period of poor regulation was made possible only by the preceding period of good regulation. In other words, good combustion was obtained with poor regulation only because the fire was in excellent condition at the outset. This important consideration seems to have been overlooked by Mr. Richardson in drawing his conclusion that regulation was not an essential matter.

The purpose of accurate stoker regulation is to do just what Mr. Richardson did prior to his test—that is, maintain a well conditioned fire—and the tests that are given illustrate in a striking manner the importance of good stoker regulation through showing the amount of abuse, or poor regulation, which an initially well-conditioned fire will stand.

The purpose of fuel regulation for an underfeed stoker is not to provide momentarily for good combustion, as Mr. Richardson infers, but maintain a well-conditioned bed of fuel, which, in turn, insures efficient combustion.

Mr. Richardson is entirely wrong in his statement that with machine stoker speed regulation it is necessary to make adjustments every fifteen or twenty minutes. The writer is in close touch with two large central stations in which relative adjustments of fuel and air are left fixed and without change for periods in excess of fifteen or twenty days—not minutes, as estimated by Mr. Richardson.

In view of the foregoing, we take exception to Mr. Richardson's conclusion that accurate stoker regulation is of no advantage to the boiler plant.

We believe he has based his conclusion on a misconception of the purpose of regulation. The tests which he gives establish, from our point of view, the importance of regulation and not the reverse. Accurate machine regulation of a stoker is actually producing excellent results and improved economy in a number of plants, and accomplishes this improvement through maintaining at all times a well-conditioned fire.

C. H. SMOOT,

New York City. Smoot Engineering Corporation.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Mud in Steam Line

Will steam generated from feed water containing impurities carry solid particles over into the steam line? *F. D. H.*

When feed water contains mud or other undissolved solid matter in minute particles, such impurities are likely to be carried over into the steam line. This usually is worse when the boilers foam or when the boiler-water level is carried too high, especially if the boilers are forced. Some of the solid matter thus carried over with the steam usually becomes deposited in the steam chest of an engine, but as nearly all of it is swept through the engine, it causes cutting of the valves, valve seats, cylinder and piston rings.

Fitting New Corliss Engine Valves

In providing new valves and reboring valve seats for a Corliss engine, what amount of clearance should there be between the size for turning the valve faces and for reboring the seats? *P. W.*

It is customary to allow a radial clearance of about 0.002 of one inch between the valve face and its seat. But the amount of clearance allowed for in machining cannot be relied upon as a final fit since the valves warp when in use. Hence the proper procedure is to make the allowance mentioned in turning and boring and, after a few days' run, scrape down the high spots shown by wear.

Removing Oil From Boiler

How can a boiler be cleaned of oil, and how can oil be removed from drips before entering a boiler? *R. H. T.*

To rid a boiler of oil, it should at the same time be thoroughly cleaned of all scale. First allow the boiler and setting to become cooled and clear out all scale that can be easily removed by mechanical means and by washing out with a hose. Then fill the boiler with water within a few inches of the top and put in about one pound of caustic soda per 8 cu.ft. of steam and water space. Allow the water to simmer for 48 hours over a gentle fire. After the boiler has cooled down, drain off the water and scrape off and wash out whatever scale has remained. The "boiling off" should make the scale soft, but it may harden again after exposure to the air, and for that reason the boiler should be cleaned quickly as possible after the water is let out. Several such operations may be necessary before the boiler is clean.

In handling the caustic soda care should be taken that none comes in contact with the hands or other parts of the body. When caustic soda is used, a good supply of dry bicarbonate of soda should be at hand. Then, if anyone is injured by the caustic soda getting in his eyes or from coming in contact with other parts of the body, the parts injured should be liberally bathed with a fresh solution made of a handful of the bicarbonate to about a half gallon of clean water.

It is best to throw oily drips away. However, when engine exhaust comes in contact with the feed water or oily drips are returned to the boiler, an oil separator or filter should be used and kept clean. Linen terry cloth is a good oil filtering medium for straining the water as it passes from the feed pump to the boiler. The cloth so used can be cleaned by boiling in water and soda, and used again. Oil can be gathered also by flowing the oily water through a filter box or tank containing hay, straw, charcoal or coke, but when any one of these is used, it should be frequently renewed. The discarded filtering material when sufficiently air dried can be used as fuel.

Determining Erosion of Turbine Blading

How may it be known if the blading of a steam turbine is badly eroded without removing the casing? *J. F.*

The only way of telling whether the blading is eroded without taking the turbine apart is by checking the quality of steam exhausted and compare the quality of the exhaust with the percentage of moisture that was present when the turbine was new and supplied with the same pressure and quality of steam and about the same load. If the exhaust is dryer, that is, shows a less percentage of moisture than formerly, that would indicate less efficient operation, attributable in every probability to worn or eroded blading. However, such a test is only inferential. To make sure that the lower efficiency is due to erosion, the turbine should be sufficiently dismantled for actual inspection of the blading. In most types of small and moderate-sized turbines examination of the condition of the blading can be made by simply removing the steam chest.

Strength of Furnace Sheets of Vertical Fire Tube Boiler

In computing the safe working pressure for the stayed furnace sheet of a vertical fire-tube boiler having a furnace 32 in. in diameter, what allowance is made for the strength of the furnace sheet itself? *J. P.S.*

If perfect cylindrical form could be relied upon and the material could be depended upon as uniform in texture, thickness and strength, the pressure required to collapse a circular furnace might be computed by the same formulas as those used for cylindrical shell subjected to internal pressure, by using the factors of com-

pressive strength of the material instead of those of tensile strength. As such cylindrical forms are not possible, theoretical formulas for the stresses in unstayed cylindrical shells subjected to external pressure are of little value, since collapse would occur long before the compressive strength of the material would be reached. Authentic information on the resistance which unstayed steel shells over 38 in. in diameter offer to collapsing pressures is not available. Hence, the sides of a plain cylindrical furnace over 38 in. in diameter should be stayed as a flat surface, except that the pitch of staybolts may be increased to p, in allowance for the arch form between staybolts, as provided in the formula:

$$p_1 = p\sqrt{\frac{P\,R}{P\,R - 250\,T}}$$

in which

p_1 = Equivalent pitch for a cylindrical surface;
p = Maximum pitch for a flat surface;
P = Maximum allowable working pressure, lb. per sq.in.;
R = Internal radius of furnace, in inches;
T = Thickness in *sixteenths* of an inch.

Noise from Small Direct-Connected Centrifugal Pump

For filling a house tank we use a small centrifugal pump that is driven by a direct-connected motor mounted on the same cast-iron base. When the combination is operated, there is a howling sound transmitted through the piping system, which is annoying to occupants of the building. How can the noise be prevented? *C. N.*

There may be some noise due to rattling of worn packing rings that need to be adjusted or replaced. This and vibrations from water carried around by the impellers, which usually produce so little sound that it can be heard only a short distance from a centrifugal, undoubtedly cause vibration of the cast-iron base. If the base is of box form, much of the noise can be quieted by filling the base casting with thin portland cement, poured through an opening in the top or through a hole cut in the top if necessary.

Concreting Around Engine Foundation Bolts

In building an engine foundation of concrete, is it necessary to leave spaces around the anchor bolts? *P. K. L.*

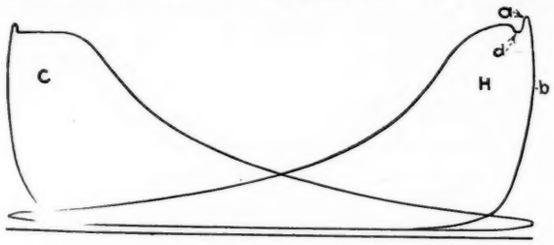
It is not necessary to leave spaces around the bolts while building the foundation, provided the bolts can be rigidly held in proper positions during the foundation construction, so they may receive the engine with proper alignment. But in the ordinary course of construction the relative position of bolts is likely to be disturbed by the concreters or the bolt templet may become moved or warped out of shape and proper position before the top of the foundation is laid. Hence it is better to leave spaces around the bolts so the upper ends of any may be moved a little to one side if required to conform better with the bolt holes in the engine when the parts are in the desired alignment.

To leave the bolt spaces in the concrete, provide 3- or 4-in. iron pipe or a wooden box about 4x4 in. around each bolt, with the upper end of each secured to the templet while the concrete is being laid. If wooden boxes are used, they can be pulled up and cut off at their upper ends from time to time as the foundation is built up, or no great harm is done to leave them in the foundation. When the engine is placed on the finished foundation in the desired alignment, approximately level and let down over the bolt ends, each bolt should be held central with its hole in the engine bases while the engine is resting on temporary supports about an inch above the foundation. Then the holes in the foundation can be filled around the bolts with a thin grouting of cement.

Irregularities of Diagrams Due to Inertia of Indicator

The illustration shows a pair of indicator diagrams taken from a 22x48-in. Corliss engine, running 84 r.p.m. Are the lumps at the admission end of each diagram due to too much compression? *W. L. C.*

Compression is necessarily highest at or before the beginning of the stroke. In the *H* diagram, the highest compression is at *b*. If the pressure at *a* were due to compression, then with a correct reducing motion it would appear at the very beginning of the stroke, whereas the beginning of the stroke is at *b*. Inclination



Irregularities due to inertia of indicator

of the line from *b* to *a* is due to tardy admission, and the rise at *a* above the general admission line is due to inertia of the indicator. These same characteristics are shown in the *C* diagram. The drop to *d* is due to richochetting of the indicator and probably is shown only in the *H* diagram because the admission valve in the head end is opened wider than in the crank end at the beginning of the stroke. Irregularities such as shown at *a* and *d* can be reduced by using a stronger spring in the indicator.

Relative Current Consumed by Single- and Three-Phase Motors

Why is it that a single-phase 5-hp. 110-volt motor will consume about one-third more current than a 5-hp. three-phase 220-volt motor? *V. K. S.*

The single-phase motor will consume over three times as much current as the three-phase motor, first, on account of the difference in voltage, and second, on account of the difference in phases. The current taken by a single-phase motor is equal to (hp. $\times$ 746) $\div$ volts $\times$ power factor. The current taken by a three-phase motor is equal to (hp. $\times$ 746) $\div$ volts $\times$ power factor $\times$ 1.732. Assuming 80 per cent power factor for each motor then, for the single-phase 5-hp. motor we have (5 $\times$ 746) $\div$ 110 $\times$ 0.80 = 42.4 amp., and for the three-phase motor the current is equal to (5 $\times$ 746) $\div$ 220 $\times$ 0.80 $\times$ 1.732 = 12.2 amperes.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Data Released on North Tees

ALTHOUGH the North Tees station, about 30 miles from Newcastle-upon-Tyne, in England, was designed in 1917 and construction work began the same year, very little information has been given out in regard to it. Yet this plant was one of extraordinary interest to engineers in all countries, as it was one of the first to embody such novel features as bleeder heating, reheating of the steam, high pressure, etc.

Much mystery surrounded the operation of this station. As is so often the case when actual facts are not made available, rumors took their place. It was said that the station was experiencing all kinds of difficulties on account of the high pressures, reheating etc. These rumors were largely denied by a representative (Charles H. Merz) of the designers, who spoke at the 1923 N.E.L.A. Convention, stating that, while some difficulties had been experienced, none of them were inherent in the innovations used.

A description of this station has been made available to engineers by the simultaneous publication (June 13 issues) of articles on the subject in the two British publications *Engineering* and *The Engineer*. The following material, including the drawings, are abstracted from these sources.

The North Tees station was designed by Messrs. Merz & McLellan, consulting engineers, for the Newcastle-upon-Tyne Electric Supply Co., Ltd. To secure the maximum efficiency, a very bold design for that date (1917) was adopted, the boiler pressure being 475 lb. and the steam temperature 700 deg. With steam reheating, bleeder feed heaters and air preheaters an over-all thermal efficiency of 21 per cent was expected in routine operation, but this ideal has not been attained, because of adverse load conditions. With improving business and increasing load it is expected that this mark will be attained, as the plant will then be run on the base load for which it was designed.

In view of the novel features introduced into the design of the new plant, it was decided to build a complete self-contained two-unit station, so arranged that it eventually could be treated as an annex to a larger station operating under the same cycle conditions, or if, as a result of experience, modifications in the cycle conditions were found desirable, it could be kept entirely separate from any extension plant.

The size of the main unit was not limited by the load. The size selected, 20,000-kw., was that which gave the best combination of high efficiency with low capital cost. The 40-cycle standard frequency on the North East Coast limited the speed to 2,400 r.p.m. As

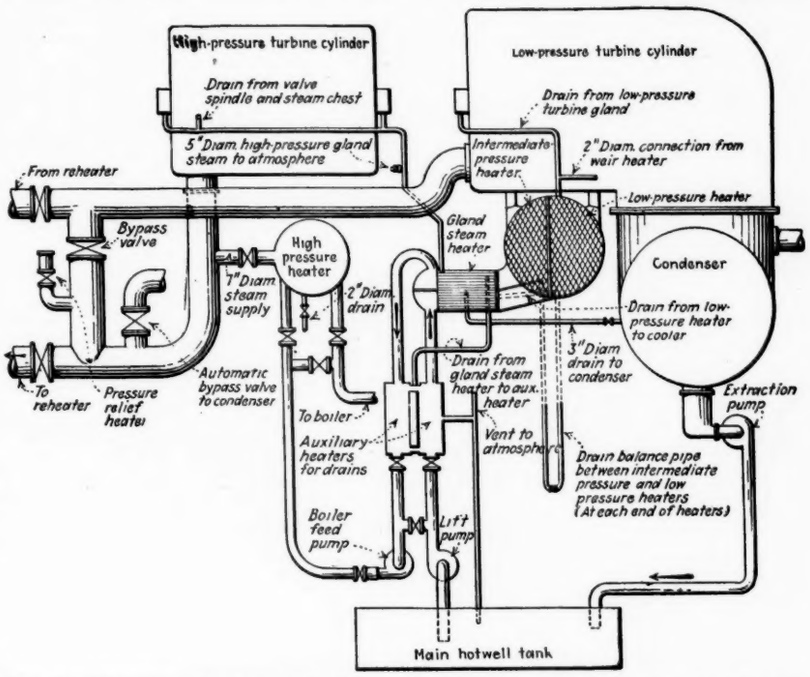

High-pressure turbine cylinder
Drain from valve spindle and steam chest
5" Diam. high-pressure gland steam to atmosphere
From reheater
Bypass valve
High pressure heater
1" Diam steam supply
2" Diam drain
Automatic bypass valve to condenser
To reheater
Pressure relief heater
To boiler
Auxiliary heaters for drains
Boiler feed pump
Lift pump
Low-pressure turbine cylinder
Drain from low-pressure turbine gland
Intermediate pressure heater
2" Diam. connection from weir heater
Low-pressure heater
Gland steam heater
Condenser
Drain from low-pressure heater to cooler
3" Diam drain to condenser
Drain from gland steam heater to aux. heater
Vent to atmosphere
Extraction pump
Drain balance pipe between intermediate pressure and low pressure heaters (At each end of heaters)
Main hotwell tank

Fig. 2—Diagram showing method of re-heating steam and heating feed water

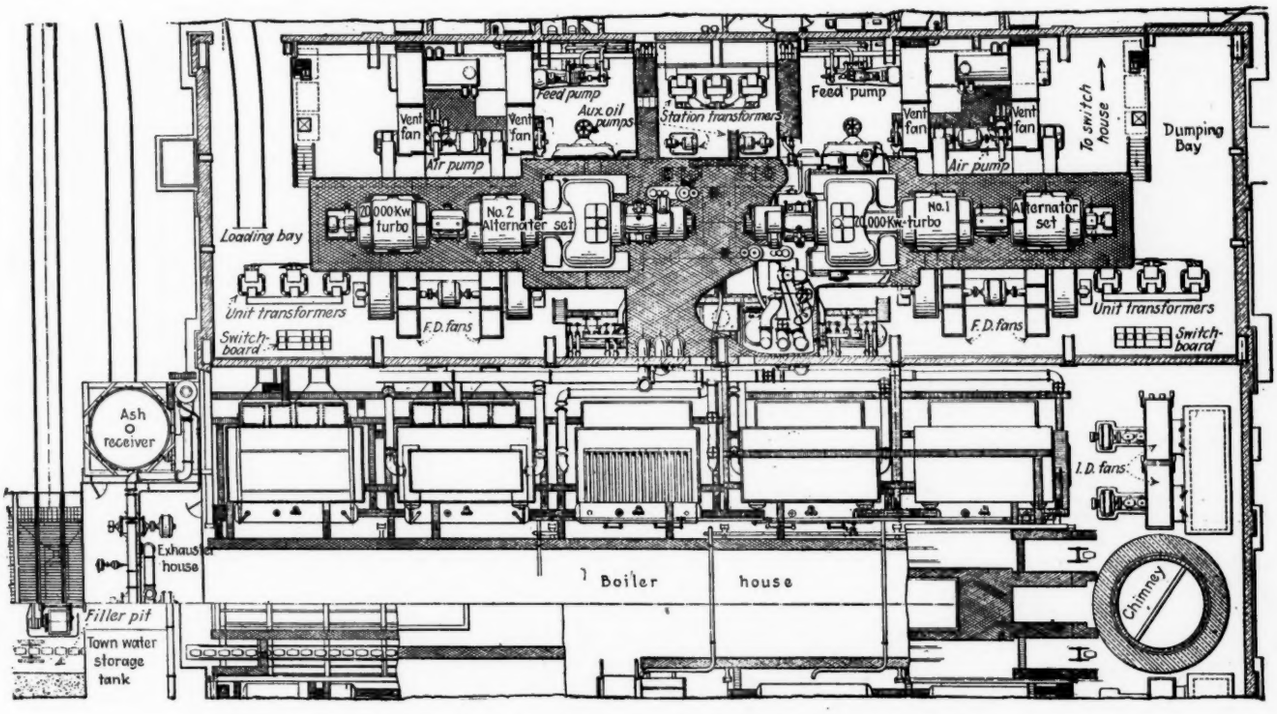


Fig. 1—Plan showing turbine room and one-half of boiler room

far as the turbine was concerned, a maximum continuous rating of 20,000-kw., with a two-cylinder, single-shaft design met these conditions. However, with the experience then available, a single generator of 20,000-kw. at 0.75 power factor could not be built for 2,400 r.p.m. Accordingly, each set was equipped with two 10,000-kw. generators, permanently connected, mechanically in tandem and electrically in parallel, with a single exciter. The most conomical load is 16,000 kilowatts.

The reheating of the steam between the high- and low-pressure cylinders is carried out by leading the steam to heaters forming an integral part of some of the boiler units. The boiler house is arranged parallel to the engine room, with the turbo-alternator sets running lengthwise.

Of the ten boilers, one row of five backs on the engine room and these are the ones equipped with heaters, to reduce the piping requirements. To prevent the accumulation of steam in the reheater from causing the turbine to run away and trip out if the load suddenly falls to zero, a special relay is provided, which operates a valve bypassing the steam from the reheaters direct to the condenser.

The feed water is warmed by three bleeder heaters supplemented by two heaters taking steam from the turbine glands and from the drains as shown in Fig. 2. The air heaters are of the simple tubular type, but with spiral retarders inside the tubes, which not only assist the heat transfer, but also enable any deposit of dust from the flue gases to be cleaned out without difficulty.

None of the special features of design of the North Tees station, such as high steam pressure, reheating of steam, preheating combustion air, etc., have led in practice to the troubles which some might have expected. The minor difficulties encountered were not attributable to the special characteristics of this station. In practice the only difficulty arising out of the higher pressure has been the liability of the gage glasses to fracture, and the cutting of the seats in the valves. These difficulties are gradually being overcome.

The North Tees station contains both motor-driven and steam-turbine feed pumps, but the latter serve merely as a stand-by, and under normal conditions the feed is furnished by electrically driven pumps taking current from the main generator.

Each generator set has a 25,000-sq.ft. condenser. The coal consumption during 1923 was 1.73 lb. per kilowatt-hour. The fuel used had a heat-value[1] of 10,990 B.t.u. While North Tees headed the list of stations in its class in the Electricity Commissioners' table issued in 1923, it has not yet reached the expected operating efficiency of 21 per cent. This, as has already been indicated, is doubtless due to the poor load factor.

The company has built a model village about one mile from the plant for the station operators. There are 73 houses laid out in artistic manner, all equipped with electric lights, electric heaters, cookers, and other conveniences.

[1]This is the "lower" heat value as customary in British practice.

PARTIAL EQUIPMENT LIST FOR NORTH TEES STATION

BOILERS		
Type of boilers	Water-tube marine, steel-cased	
	With Reheater	Without Reheater
Number installed	5	5
Heating surface of boiler, sq.ft.	6,756	6,980
Heating surface of superheater, sq.ft.	3,050	3,050
Heating surface of reheater, sq.ft.	5,490	
Heating surface of air heater, sq.ft.	10,560	9,245
Grate area, sq.ft.	196	168
Water economizers	None	None
Type of stoker	Traveling grate	
Steam pressure at superheater outlet, lb. gage	475	
Steam temperature at superheater outlet, deg. F.	700	
Normal evaporation per hour per boiler, lb.	42,000	
Continuous overload capacity, per cent	25	
Air pressure in main air flue, in. of water	3½	
Normal capacity of reheater, lb. of steam per hour	75,000	
Maximum capacity of reheater, lb. of steam per hour	90,000	
Pressure of steam to be reheated, lb. gage	65	
Steam temperature entering reheater, deg. F.	350	
Steam temperature leaving reheater at normal output, deg. F.	520	
Drop in pressure, lb. per sq. in.	¾	
Outlet temperature flue gases from air heaters, deg. F.	300	
Temperature of air entering stoker, deg. F.	350	
TURBO-ALTERNATORS		
Number installed	2	
Output of each set:		
Maximum continuous rating at 0.75 lagging power factor, kw.	20,000	
Economical rating, kw.	16,000	
Voltage	11,500	
Cycles per second	40	
Revolutions per minute	2,240	
Type of turbine	Two-cylinder Rateau with one Curtis wheel	
Normal pressure at turbine stop valve, lb. gage	450	
Normal temperature of steam at stop valve, deg. F.	650	
Maximum temperature of steam at stop valve, deg. F.	750	
Normal vacuum in condenser (30 in. bar), in.	29½	
Temperature to which steam is reheated, deg. F.	500	
Pressure at which steam is reheated, lb. gage	65	
Number of stages:		
High-pressure	6	
Low-pressure	10	
Points at which steam is bled for feed heating, lb. absolute	60, 17, 5	
Feed water heated to, deg. F.	300	
Number of alternators, per set	2	
CONDENSERS		
Number of condensers per set	1	
Cooling surface, sq.ft.	25,000	
Quantity of cooling water, gal. per min.	26,000	
External diameter of tubes, in.	1	
FEED SYSTEM		
Arrangement	Condensate pump delivers to the hotwell. Lift pump delivers through drain, low pressure, intermediate pressure and gland heaters to boiler-feed pump. Feed pump delivers through high-pressure heater to feed range.	
Feed pumps	Two electrically driven and two steam turbine-driven as standby.	
Capacity per pump, lb. per hour	250,000	

Legal Duty in Handling Steam

BY A. L. H. STREET

"Steam is so far a dangerous agency that a high degree of care is required of those engaged in its production and use," declared the Oregon Supreme Court in the case of Hicks vs. Peninsula Lumber Co., 220 Pacific Reporter, 133.

The plaintiff sued for personal injuries sustained through the negligent operation of a steam power plant by the defendant's employees, while plaintiff was assisting in installing a mud drum under the boilers, as an employee of a contractor. He was working in the drum when the defendant's foreman ejected steam from a live boiler into a blowoff pipe line that had been connected with the drum by the defendant's employees a few hours earlier. No notice that the connection had been made had been given to the plaintiff, his foreman, or any of the men working with him. The Supreme Court affirmed judgment in plaintiff's favor, making the declaration quoted above and saying further:

"The conditions under which plaintiff was employed and working upon the defendant's premises imposed upon defendant the same legal obligation and duty to keep the premises and the place at which plaintiff was at work in a reasonably safe condition, as would have rested upon it if plaintiff had been employed by defendant at the time and place of his injury. . . .

"Defendant was not an insurer of the safety of plaintiff against injury from the steam generated and used by defendant in its plant where plaintiff was working. Under the circumstances shown by the evidence, it was incumbent upon the defendant to exercise ordinary care for the safety of plaintiff, or a degree of care corresponding to the danger involved. . . .

"It is obvious that if the valves in the drain pipe which has been described had been closed at the time the live boiler was blown off by defendant's night fireman, plaintiff would not have been injured."

Reviewing the evidence adduced at the trial, the Supreme Court further decided that it "justified the jury in drawing the inference that the valves were open at the time steam was turned into the pipes, as the result of negligence, and that defendant was responsible for that negligence, and also authorized the inference that defendant failed to exercise due care to ascertain whether or not the valves in the exhaust steam line were open, before blowing off the live boiler in defendant's plant."

Interstate Commerce Warns Against Delaying Purchase of Coal

Bituminous Coal Production Decreased—Transportation Needed for Crops Later—Coal Stocks Low

A WARNING was issued July 19 by the Interstate Commerce Commission, calling attention to the necessity for the purchases of coal at this time if the disruption incident to a high peak in the coal movement this fall is to be avoided. The full text of the Interstate Commerce Commission's statement is as follows:

The average production of bituminous coal per year for the past seven years (exclusive of the strike year 1922) has been approximately 520,000,000 tons. The average production in the last six months of such years was 6.8 per cent greater than the average for the first six months. For the first half of this year production has been about 227,639,000 tons. If in the last half of this year production is 6.8 per cent greater than in the first half, the total for the last six months will be 243,118,000 tons, or an average of 9,500,000 tons weekly for weeks of six working days each. Since April 1, 1924, the bituminous coal produced has been less than 7,500,000 tons per week in each instance.

It can readily be seen, therefore, that if shipments of bituminous coal for winter consumption are deferred for any considerable length of time, the railroads will be called upon to handle a very large quantity of coal during the peak freight movement in the fall.

The aggregate of bituminous coal shipped via lake to the Northwest during the 1924 season of Lake navigation to June 30, plus bituminous coal stocks at the head of the lakes April 1 of this year, is 12 per cent less than the corresponding figure for 1923 and 16 per cent less than the corresponding total for 1921, although larger than in 1920 and 1922. However, during the fall months of 1920 and 1922 there were severe car shortages, and in the latter year a miner's strike.

The coal stocks on docks at Duluth, Superior, Ashland and Washburn, June 15, 1924, aggregated 3,125,663 tons, as compared with 2,179,999 tons on June 15, 1923, or an increase of 944,664 tons, thereby indicating that considerably less coal has been distributed from the head of the lakes than at this period last year.

Roads in the Northwest will soon be taxed to their utmost with the heavy demand on transportation in the fall months, during which period we will undoubtedly have a very heavy movement of agricultural products. It is therefore urgently suggested to the people of the Northwest that they purchase their coal early, in order to avoid a curtailment in the transportation necessary for the heavy movement of agricultural products.

There are no definite records available respecting present coal stocks. The stocks as of Jan. 1, 1924, aggregated 62,000,000 tons. At that time railroad coal stocks totaled 19,367,956 tons, as compared with 15,530,327 tons June 1, which is a decrease of 20 per cent. If the same percentage of decrease is applied to the aggregate coal stocks, the figure as of Jan. 1 would be reduced to 49,600,000 tons, which may or may not be a fair approximation of the coal stocks as of June 1, 1924.

It is thought advisable to call the attention of the public at this time to the foregoing situation. The fall months are usually the peak months of transportation, and if the carriers are called upon to handle an enormous coal traffic during those months in addition to the other commodities which they are called upon to transport, their facilities will be taxed to the utmost.

The necessity for increasing coal production prior to the peak movement would seem apparent if we are to avoid transportation shortages.

Trade Association Statistics Pronouncement Deferred

The difficulty of explaining a policy on a controverted question may preclude the Department of Justice from making any announcement before the election on trade association statistics.

There is reason to believe that the new Attorney General is in thorough sympathy with removing any uncertainty that may surround trade association activities. He is thought to realize, however, that it is difficult to know just how a line can be drawn that would clarify the matter. It is certain that there is no disposition to allow the study now being made of the general subject to interfere in any way with the prosecution of those who are using the trade association as a cloak to defeat the purpose of the anti-trust statutes. On the other hand, there is reason to believe that trade associations who are engaged in those activities generally recognized as being legitimate, are in no danger of prosecution.

French Experimenting With Gasoline Substitute

The effort to obtain a gaseous motor fuel from charcoal has for some time occupied both science and industry in France, where the importation of gasoline now amounts to 1,000,000,000 francs annually and has a deteriorating effect on French exchange, Consul Damon Wood, Paris, reports to the United States Department of Commerce. Recent issues of *le Bois* and *Bois et Resineux*, leading French lumber journals contain descriptions of the demonstration of the "Imbert gazogene," an apparatus for producing charcoal gas, which recently took place in the Berliet factory at Lyon before representatives of the Ministry of War and of the press.

The machine used in the experiment was a Berliet automobile of 25 hp. The "Imbert gazogene" according to these descriptions creates carbon monoxide by the contact of air with the incandescent charcoal; the gas is mixed with air and introduced into the motor cylinders, and the remainder of the process is similar to that in a gasoline motor. The engine can be started in a few moments after the charcoal is fired. The gazogene weighs 50 kilograms (1 kilogram equals 2.204 pounds) and consumes 15 kilograms per 100 kilometers (62.14 miles). Its heater and purifier, with charcoal sufficient for 200 kilometers, are behind the vehicle.

During 1923 France imported 728,000 tons of gasoline. If the new process proves practical, it is claimed this can be replaced by an equal weight of charcoal furnished from the French forests, which give annually 18,000,000 cubic meters of wood, one cubic meter yielding 168 kilograms of charcoal.

The Council of National Defense is directly interested, as the 100,000 automobiles indispensable in war may be driven by French fuel derived from charcoal instead of gasoline shipped from foreign countries, whose importation could be prevented by the enemy or by the foreign oil groups which have monopolized this commerce. Charcoal from a military standpoint is also safer than gasoline, as the storage depots cannot be fired with explosives, nor will airplanes be in as great danger from incendiary shells. Economy has been made another argument which the promoters advance. The expense of running a 25-hp. motor vehicle by gasoline is from 36 to 40 francs per 100 kilometers; by the use of charcoal it is claimed that this cost can be reduced to 5 or 6 francs. The promoters say that the gasoline motor may be readily converted to a charcoal-burning one without diminishing its efficiency.

Lloyd George Committee's Report on British Coal and Power Published

Socialization of Mines Not Solution of Mining Industry—Purchase of All Minerals and Royalties by the State Advocated —Private Operation Advised

THE REPORT of a committee presided over by Lloyd George, which inquired into the conditions of the coal industry and the use of power, was published in London recently. The main conclusions arrived at by the committee are as follows:

Neither the miners nor the mine owners nor the public are contented with the condition of the mining industry today; the socialization of the mines would not solve the real problems of the mining industry, but would almost inevitably result in lower wages and higher prices of coal as well as other evils; the line of advance is by—the unified ownership and control of the mineral resources of the nation, judicious amalgamation or grouping of the mines, altering the status of the miner in the industry, concentration on better mines and the progressive development of new mines for old, better housing and reconstruction of mining village conditions, the conversion of coal into electricity.

The committee's practical proposals for giving effect to these reforms, so far as Parliament can do so, are as follows:

Purchase of all mineral and royalties by the state; administration of the national mineral estate by a body of non-political Royalty Commissioners, for the purpose of facilitating amalgamation and grouping of mines; encouraging the development of better mines; and insistence on adequate housing and village arrangements as a condition of lease to mine coal.

Provisions are given for statutory consultation about the problems of the industry between miners and mine-owners on equal terms at three points, while leaving executive functions on which efficiency and therefore prosperity depend, in the hands of those responsible for the success of mining operations. The three points are pit committees, district boards and a National Mining Council. In addition to consultative functions, the National Mining Council to have the following duties: Discussion of policy to be pursued by the Royalty Commissioners with the right of appeal to Minister of Mines to override decisions; and administration of a special Housing and Welfare Fund consisting of the present 1d. a ton levy, amounting to £1,000,000 a year, and a 10 per cent deduction from the purchase price of royalties, estimated at a capital sum of about £7,000,000.

The committee also came to the following conclusions:

No reorganization of the coal mining industry, however well designed, will produce its full benefit without a better conversion of our coal resources and water-power resources into electrical energy. Other countries since the war have enormously increased their electrical power installations; Great Britain has lagged far behind. The economical conversion of coal into electrical power result in cheaper power, saving of coal, elimination of waste, financial saving, smoke abatement, better and cheaper railway transport, by-product industries, and revival of rural industry.

In order to achieve the foregoing results it is recommended:

"That adequate power should be conferred upon the Electricity Commissioners to enable them, with the aid of private enterprise, to establish a national system of electrical generation and distribution.

"That by means of a system of state credits, or by granting of special assurances as regards demand for electricity or as regards dividends, private capital should be encouraged by the Electricity Commission to develop the supply and transmission of electricity on a national scale.

"That powers should be conferred enabling the state to undertake through the medium of the Electricity Commission, the work of laying electrical trunk mains in special circumstances.

"That the Electricity Commission should have the powers of compulsory acquisition to give effect to our proposals, and to remove vested electricity interests where they stand in the way of the public interests, and in particular, to acquire all necessary water rights.

"That the national system should be so designed and developed as to encourage the conservation of fuel resources, the utilization of byproducts, and the development of new industries.

"That special regard should be had to the desirability of developing rural industries and extending the use of electricity to the country side."

A foreword has been contributed by Lloyd George, who points out that Mr. Asquith fully approves the committee's recommendations. The report, he says, has been prepared in no partisan spirit, but is published as a contribution toward the solution of an urgent problem facing the nation.

The report states: Both theory and experience combine to show that nationalization in any form reduces efficiency, and therefore either diminishes the amount available for wages or increases the price of the product. It is impossible to divorce ownership and responsibility from power without disastrous results.

"The objections to trustification in private hands are generally recognized. The objections to trustification in the hands of the miners seem to be just as great. The temptation in both cases to increase wages or profits by raising the price to the consumer would be immense, with disastrous results to the national industries and, ultimately, to the miners themselves."

The unified control of the mineral resources of the kingdom is recommended, and it is pointed out that the first essential for this development is that the state should acquire from the 4,000 royalty owners their coal measures and the incidental right to levy royalties for permission to work them. These mineral resources would be vested in a single central authority, known as the Royalty Commissioners. At the same time the state should own such further coal measures as may be discovered and ascertained to be workable.

The abolition of the Ministry of Mines is not proposed. That department will continue to perform very much its present functions.

Heat Engine and Boiler Trials Session Held

Taking advantage of the fact that so many engineers were overseas attending the World Power Conference, the Committee on Heat Engines and Boiler Trials, which is composed of four members each of the Institution of Civil Engineers, Institution of Mechanical Engineers, Institution of Electrical Engineers and other allied societies of Great Britain, a session was held at which Captain H. Riall Sankey, C. B., C. B. E., presented a paper outlining the scope of the committee's work.

This work is to prepare codes for the standardization of the testing of heat engines, not only for commercial trials, but also for the comprehensive trials for scientific purposes. The latter are intended for making comparisons with the performance of other similar types of plant and for accumulating information that will be of value to designers and others interested in the production and use of such plant, and also for formulating laws and checking theories governing the performance. Trials for commercial purposes require in general only such measurements as will establish whether the guarantee given by the vendor has been fulfilled as regards efficiency, performance and output. The fundamental difference between trials for scientific and commercial purposes is that the former require the measurement of losses.

Beside the paper the following subjects were discussed:

In the 1913 Code the lower calorific value was adopted—after discussion the present Committee propose to adopt the gross (or higher) calorific value; it is proposed to omit from the Boiler Code the expression "lb. of steam evaporated from and at 212 F"; the committee does not propose to include "Boiler Horse Power." These changes are all in line with the Power Test Codes of the A.S.M.E. Beside these changes the question, "Are water meters and steam meters admissible in comprehensive trials for scientific purposes"? was discussed at some length.

The following codes are being prepared by the Committee: Boiler and its accessories, steam reciprocating engine, steam turbine, condensing plant, gas engine, gas producer, petrol and paraffin engine, heavy-oil engine.

Swing-Johnson Bill Advocated by Boulder Dam Association

Awakened by one of the most severe droughts in the history of southern California to the fact that the Colorado River development must be commenced at once if water and power are to be available for continued growth of the Pacific Southwest, representatives of more than 100 municipalities, irrigation districts and civic associations, meeting July 19 for the first annual session of the Boulder Dam Association, pledged their united efforts to work for immediate passage of the Swing-Johnson bill when Congress reconvenes.

It was agreed unanimously by the officially accredited delegates, after two hours of discussion in which the pros and cons of the "All-American Canal" feature of the Swing-Johnson bill were the sole issue, that the bill as it now stands will do the greatest ultimate good impartially to every part of the territory involved and should be passed without further delays or substitutions.

The failure of Arizona to ratify the Colorado River compact long indorsed by the six other states involved, was pointed out as the principal objection of the "Upper Basin" states, Colorado, Wyoming, Utah and New Mexico, to passage of the bill because this compact assures to the states their share of Colorado water; but the belief that the Arizona people will settle the matter in November was expressed generally. Col. B. F. Fly, of Yuma, declared in this connection: "I have a very strong feeling that Arizona will ratify at the coming election."

Clyde Seavey, chairman of the California railroad commission and William Holland, chief water engineer for the City of Los Angeles and builder of the Los Angeles acqueduct, were among those who pointed out the effects of the present water and power shortage upon the Pacific Southwest, declaring that rivers have dwindled from streams of large volume practically to nothing with resultant losses of hydroelectric power which have drained the vitality of industry wherever affected.

Opposition to the All-American Canal feature of the Swing-Johnson Bill on the part of two Imperial Valley visitors, opened the subject of greatest controversy involved in this legislation —the campaign of private power interests to defeat the bill and place developments of the river in the hands of corporations rather than of the people, according to press reports. The canal was defended as one of the most important features of the bill by Earl Poind, a director of the Imperial irrigation district, D. B. Irvine, president of the Imperial County Farm Bureau, Colonel Fly, and others, who charged that propaganda against the canal comes from the power trust and from American owners of Mexican lands, headed by the Chandler interests.

In this connection Ralph L. Criswell, member of Los Angeles council said:

"This is a contest between the interests which seek a monopoly of the natural resources of this Nation and those who believe that they should be forever preserved and utilized for the benefit of the people."

Power Conference Engineers Honor "Scythia's" Chief

The delegates aboard the "Scythia," going to the World Power Conference at Wembley, Eng., were so well entertained by Chief Engineer Bain and his staff, and enjoyed their visits to the engine room to such an extent that they had to express their appreciation of these courtesies in some way. So the following graceful tribute was presented to them at the completion of the delightful trip over:

On Board S.S.Scythia,
June 25th., 1924.

We, the undersigned American engineers attending the World Power Conference, do hereby tender our greetings to the Chief Engineer of the Scythia, Mr.G.Bain, and his staff and wish to express to him our appreciation of his courtesies to us.

Beside this testimonial the ship's engineers were given souvenirs, such as clocks, passport cases, pipe and tobacco pouches, pencils, candy, etc. A good time appears to have been had by all.

Tablet to Ericsson To Be Unveiled July 31

On the 121st anniversary of the birth of Captain John Ericsson, Thursday, July 31, at 2 p.m., there will be unveiled with appropriate ceremonies in which representatives of the federal, state and municipal governments will participate, a bronze tablet by Anton Schaff, at 95 Franklin St., New York City, which was the residence of Captain Ericsson when in 1862 he designed and superintended the construction in 100 working days contract time of the iron clad "Monitor" which turned the tide of the Civil War in her battle with the "Merrimac."

The tablet is being erected by the families of three men whose faces with Captain Ericsson's are depicted on it. These men were Cornelius S. Bushnell, of New Haven, Conn., and John F. Winslow and John A. Griswold, of Troy, N. Y., who secured the contract from the government and furnished the funds and supplied the materials to build the vessel. The flag to be used in the unveiling is the one which floated on the Monitor during the battle and was draped over the body of Captain Ericsson when it was transported to Sweden in 1890 on the U. S. S. Baltimore by Captain later Admiral Winfield Scott Schley.

Large Power Possibilities on Flathead Lake

The Geological Survey's engineers, Benjamin E. Jones and Edward E. Jones, have recently completed a study of the power possibilities of the South Fork of Flathead River, which is on the west side of the Continental Divide in northwestern Montana and which flows into the Columbia River. The report that on account of its altitude and the size of Flathead Lake, the Flathead River has been studied frequently with the idea of developing storage to improve its flow and that of Clark Fork and of the Columbia. Such storage would be particularly advantageous to the 300 ft. of head between the lake and the junction with the Clark Fork and to a less extent to four sites below the junction, having a total head of 732 ft.

Flathead Lake, with an area at ordinary stages of 120,000 acres, forms a natural reservoir for the regulation of the flow of the river. A natural dam site a few miles below the outlet provides the necessary facility for raising the level of the lake to almost any desired height, although unfortunately the town of Kalispell, situated near the upper end of the lake, is not much above the present high-water level.

The storage of 1,600,000 acre-feet, the assumed capacity of Flathead Lake reservoir, increases the low-water flow of Flathead River below Flathead Lake to a minimum in 14 years of 5,460 sec.-ft. and to an average yearly minimum of 7,580 sec.-ft.; the storage of 1,200,000 acre-feet additional will increase the minimum flow to 7,680 sec.-ft. and the average minimum to 9,860 sec.-ft.

A dam 350 ft. high is proposed, with a drawdown of 200 ft., which will provide

1,200,000 acre-feet capacity for storage and an average head of 283 ft. for power. The spillway will be a short open cut in the rock around the west end of the dam. With a head of 283 ft. and a flow of 4,140 sec.-ft., at 70 per cent efficiency the project should provide 94,000 continuous horsepower. To this should be added the additional 182,000 hp. made available at sites on Flathead River and Clark Fork, giving at an assumed efficiency of 70 per cent, a total of 276,000 horsepower.

Capacity of Generators in the United States

The Geological Survey recently published figures showing the total capacity of generators in the power plants of the United States whose output is included in its monthly report, published from time to time in *Power*, and which is based on reports received from about 4,000 electric-power plants generating electricity for public use.

At the present time these capacities are:

	Capacity of Generators	
	Kilowatts	Per Cent of U. S. Total
United States	17,796,026	100.0
New England States	1,808,710	10.2
Middle Atlantic States	4,777,068	26.8
East North Central States	3,921,774	22.0
West North Central States	1,405,990	7.9
South Atlantic States	1,960,486	11.0
East South Central States	756,455	4.3
West South Central States	542,313	3.1
Mountain States	719,120	4.0
Pacific States	1,904,110	10.7

Albany Would Like Water from Power Reservoir

According to press reports the question of the right and expediency of permitting a municipality to utilize a state-built reservoir as a source of water supply is raised by the announcement of Mayor Hackett of Albany, N. Y., that he is considering making such a request of the 1925 Legislature.

Albany has been looking about for a year for a new water supply. The state, through the Hudson River Regulating Commission, is constructing the Sacandaga reservoir at Conklinville, just below Lake Luzerne, in order to regulat the flow of the Hudson for power purposes.

The dam will not be otherwise utilized, and, in the opinion of Albanians, what could be better than to connect it with Albany's water faucets by a pipe line? Incidentally, it would save Albany the expense of building another reservoir.

Mayor Hackett has talked with the members of the Regulating Commission, Edward H. Betts of Troy, Erskine C. Rogers of Hudson Falls, and former Senator Henry M. Sage of Albany, and reports that they do not consider that it would hinder the use of the reservoir for its original purpose if the amount of water needed by Albany were diverted.

It would be an advantageous thing for the city if a water supply could be thus obtained from a state enterprise. The cost of the dam is estimated at $8,500,000, of which $8,100,000 is to be paid by power companies which will derive benefit from the department. The other $400,000 will be paid by cities along the river—Albany, Troy, Watervliet, Fort Edward, Rensselaer and a few others. Albany's share of this amount is $232,000, or 2.7 per cent of the entire cost.

Several difficulties beset the plan. Not the last of these is the precedent which would be created. It would be the first instance in New York of a state power development being used by a municipality.

The power concerns which are paying the major cost of the Sacandaga reservoir might object, it is thought, to being charged for a development which would benefit the City of Albany even more than themselves, and at virtually no cost.

Power Takes Precedence Over Fish Rights

In authorizing a preliminary permit for the Electrometals Co., covering an important development on the Klamath River in northwestern California, the Federal Power Commission has given a significant indication of its attitude toward protests against high dams by fish interests. The preliminary permit was authorized in this instance over unusually strenuous protests from the California Fish and Game Commission and from Representative Raker, of that state. It is the opinion of the commission, however, that the problem of passing fish over high dams can be solved. It is believed that this problem can be worked out during the time it is necessary for the surveys of the project, the preparation of plans and the perfection of financial arrrangements. The effect in this instance is to allow the preliminary work to go ahead on a project that promises much for northern California and for the country as a whole.

The Electrometals project covers two dams in the Klamath River at which 127,000 hp. can be developed. The application is made jointly, however, with one by A. P. Seybold, which provides for a third dam at which 30,000 hp. can be developed. These applications were filed nearly four years ago. The plans of the applicants have been interfered with by the delay. The point had been reached where definite action on their application no longer could justly be denied them. The development of cheap power on the Klamath is the basis for an important project for manufacturing aluminum at Trinidad, a port on the Pacific just north of Eureka. The granting of the permit was urged by the San Francisco Chamber of Commerce and by all civic organizations in Humboldt County with the single exception of the canners' association.

For two years an intensive controversy over this project has raged in California. A thorough study of the proposed development by the Division of Water Rights of the Department of Public Works of California resulted in a decision to grant the necessary state rights for this project. The Fish and Game Commission has carried the matter to the courts, but the Federal Power Commission saw no reason to withhold the preliminary permit after the state rights had been granted.

Mine Workers Win Famous Coronado Case

The United Mine Workers of America are absolved from financial liability in the celebrated Coronado Coal Mining Case, in a decision filed July 12 in the United States Circuit Court of Appeals in St. Louis. The suit in which the coal company sought damages from the union for destruction of its property during a strike in 1914, has been in the courts ten years. It was instituted first at Fort Smith, Ark. The new decision is expected to end the litigation. The opinion given by Circuit Judge Kenyon, and concurred in by Circuit Judges Sanborn and Lewis, quotes the rule laid down by Chief Justice Taft of the United States Supreme Court which holds that "to recover under the inhibitions of the Sherman anti-trust act evidence sufficient to show the union intended to interfere or monopolize interstate commerce must have been adduced" and that there was not this evidence in the case under consideration.

The decision also affirms the ruling of District Judge John C. Pollock that coal mining is not interstate commerce and does not fall within the jurisdiction of the interstate commerce sections of the Anti-trust Act. The decision overruled contentions by the company that the mine workers' union had conspired to interfere with interstate commerce.

Power Exposition Shows Progress

Over 260 exhibitors have been assigned space at the Third National Exposition of Power and Mechanical Engineering, which will be held in the Grand Central Palace, New York City, Dec. 1-6. As this is more than twice the number of those who had engaged space on August first a year ago, the indications are that the coming event will be of tremendous interest.

The 1923 exposition drew an attendance of 62,079 engineers, executives, financiers, operating men, as well as large numbers of engineering students with their instructors. This is an increase of 15,000 over the number who attended the 1922 exposition.

The exposition will, as usual, parallel the meetings of the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers. The A.S.M.E. meeting will be held in the Engineering Societies Building, 29 West 39th St., New York City, and the A. S. R. E. meeting will be held at the Hotel Astor, New York City. Plans are under way for the American Society of Heating and Ventilating Engineers to have a gathering of local sections during the time of the exposition. The co-operation of the various engineering societies has been valuable, since it enables members to attend the meetings and at the same time see the interesting exhibits at the Grand Central Palace.

Good Business Relations With Canada

According to *Commerce Reports*, Canada is today the second best foreign market for American produce and manufactures, has the highest per capita consumption of American goods, and is also our chief source of supplies. Though in reality Canada is a foreign market, its proximity and accessibility for domestic salesmen gives it many of the features of a domestic market. Our trade with Canada is on a favorable basis, as our merchandise balance has for years shown an excess of exports.

In 1913 we exported over $261,000,000 more to Canada than we imported from there. This condition continued throughout the war period, and in 1923 the excess was $136,000,000. In 1913 Canada was third on the list of countries exporting to the United States, with $142,000,000 worth of goods, while England and Germany held first and second places, respectively. In 1923 Canada was first with $416,000,000, and England and Cuba took second and third places, respectively. This was an increase in imports from Canada of over 190 per cent.

Society Affairs

The American Society of Refrigerating Engineers has appointed a committee, of which F. N. Speller is chairman, for the purpose of studying the question of corrosion and determining upon some practical means for carrying out a definite program of research. At a recent meeting it was decided to ask the following associations to co-operate in the research:

American Association of Ice and Refrigeration; National Association of Ice Industries; Cold Storage Division, American Warehousemen's Association; National Association of Practical Refrigerating Engineers; Refrigerating Machinery Manufacturer's Association; United States Fisheries Association; Institute of American Meat Packers.

Among the problems discussed at the meeting were those of refrigerating coils and brine systems, condenser pipes and other apparatus in both compressions and absorption plants, cooling towers, freezing tanks, etc. The Laboratory of the Massachusetts Institute of Technology was selected for the research.

Business Notes

The Universal Coal Spreaders Co., 53 West Jackson Blvd., Chicago, Ill., announces the appointment of S. G. Elbe as the company's representative in the Denver territory. His local address will be 211 Tramway Bldg., Denver, Colo.

The B. F. Sturtevant Co., manufacturer of power-plant equipment, Hyde Park, Mass., announces that E. Jones, formerly of the Chicago office, has been appointed district sales manager of the Missouri, Kansas and Nebraska territory, with headquarters at 722 Dwight Bldg., Kansas City, Mo.

Coming Conventions

American Chemical Society. Dr. Charles L. Parsons, 1709 G St., N. W., Washington, D. C. Sixty eighth meeting at Cornell University, Ithaca, N. Y. Sept. 8-13.

American Electric Railway Association. James W. Welsh, 8 West 40th St., New York City. Meeting at Atlantic City, Oct. 6-10.

American Electrochemical Society. Dr. Colvin G. Fink, Columbia University, New York City. General meeting at Detroit, Mich., Oct. 2-4.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Fall convention at Pasadena, Calif., Oct. 13-17.

American Institute of Mining and Metallurgical Engineers. F. F. Sharpless, 29 West 39th St., New York City. Autumn meeting at Birmingham, Ala., Oct. 13-15.

American Society of Civil Engineers. John H. Dunlap, 29 West 39th St., New York City. Fall meeting at Detroit, Oct. 23-25.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Dec. 1-4.

American Society of Refrigerating Engineers. W. H. Ross, 35 Warren St., New York City. Annual meeting at New York City, Dec. 1-3.

Association of Iron & Steel Electrical Engineers, John F. Kelly, 1007 Empire Bldg., Pittsburgh, Pa. Annual meeting and exposition at Duquesne Garden, Pittsburgh, Pa., Sept. 15-20.

British Association for the Advancement of Science at Toronto, Canada, Aug. 6-13.

Exposition of Inventions. American Institute, 47 West 34th St., New York City. Exposition to be held in the Engineering Societies Building, 29 West 39th St., New York City, Dec. 8-13.

Illuminating Engineering Society. Norman D. MacDonald, 29 West 39th St., New York City. Convention at Briarcliff Lodge, Briarcliff Manor, N. Y., Oct. 27-31.

International Union of Steam and Operating Engineers. Dave Evans, 6334 Yale Ave., Chicago, Ill. Biennial convention at Detroit, Mich., Sept. 8-13.

National Association of Practical Refrigerating Engineers. E. H. Fox, 5707 West Lake St., Chicago, Ill. Convention at New Orleans, La., Nov. 11-14. Exhibits at the Isaac Delgado High School.

National Association of Stationary Engineers. Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Hotel Pantlind, Grand Rapids, Mich., Sept. 8-13. Annual conventions and exhibitions of the state associations are scheduled as follows: **Minnesota Association** at Fairbault, Minn., July 31, Aug. 1-2. C. A. Nelson, 800 22nd Ave., N. E. Minneapolis. **Michigan Association** at Grand Rapids, Sept. 8. Wm. H. Yeomans, 209 Plainfield Ave., Grand Rapids. **Pennsylvania State Association** at Grand Rapids, Mich., Sept. 8. J. N. Calvert, Union & Ridenour Ave., Crafton, Pittsburgh, Pa.

National Exposition of Power and Mechanical Engineering. C. F. Roth, Grand Central Palace, New York City. Annual exposition at New York City, Grand Central Palace, Dec. 1-6.

National Safety Council, W. H. Cameron, 168 N. Michigan Ave., Chicago, Ill. Thirteenth Annual Safety Congress at Louisville, Ky., Sept. 29 to Oct. 3.

New England Water-Works Association, Frank T. Gifford, 715 Tremont Temple, Boston, Mass. Annual convention at Powers Hotel, Buffalo, N. Y., Sept. 23-26.

Universal Craftsmen Council of America. John F. Amos, P. O. Box 299, Rochester, N. Y. Meeting at Hotel Sherman, Chicago, Ill., Aug. 5-8.

Trade Catalogs

Valves—The Ohio Brass Co., Mansfield, Ohio. Leaflet, "Getting the Formulas and Keeping Them Uniform Makes Profits for Yourself and Customers."

Packing—The Johns-Pratt Co., Hartford, Conn. Leaflet, "Vulcabeston, Lubricated Twist Valve Stem Packing," describes this packing, which is applicable to all valves.

Hose, Metal—Breeze Metal Hose & Mfg. Co., 250 South St., Newark, N. J. Leaflet, "Flexmet Products," describes bulletins covering flexible electric arms, pressure hose, etc.

Instruments, Switchboard — Roller-Smith Co., 233 Broadway, New York City. Bulletin No. 430, which is well illustrated, describes ammeters, voltmeters, volt-ammeters, shunts, multipliers, etc.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	July 14, 1924	July 21 1924
Pool 1	New York	$2.90	$2.90
Smokeless	Columbus	2.35	2.35
Clearfield	Boston	2.00	2.10
Somerset	Boston	2.15	2 25
Kanawha	Columbus	1.60	1.60
Hocking	Columbus	1.85	1.80
Pittsburgh No. 8	Cleveland	1.90	1.85
Franklin, Ill.	Chicago	2.50	2.50
Central, Ill.	Chicago	2.25	2.25
Ind. 4th Vein	Chicago	2.50	2.50
West Ky.	Louisville	1.75	1.75
S. E. Ky.	Louisville	1.75	1.75
Big Seam	Birmingham	2.10	2.00

FUEL OIL

New York—July 24, light oil, tank-car lots, 28@34 deg. Baumé, 5¼c. per gal., 36@40 deg. 5½c. per gal., f.o.b. Bayonne, N. J.

St. Louis — July 15, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.55 per bbl.; 26@28 deg., $1.60 per bbl.; 28@30 deg., $1.65 per bbl.; 30@32 deg., $1.75; 32@36 deg., gas oil, 4.5c. per gal.; 38@40 deg., 5.5c. per gal.

Pittsburgh—July 16, f.o.b. local refinery, 30@40 deg., fuel oil, 5⅛c. per gal.; 36@40 deg., fuel oil, 5⅝c. per gal.; 34 deg., neutral, 8½c. per gal.

Dallas—July 18, f.o.b. local refinery, 26@30 deg., $1.35 per bbl.

Philadelphia — July 18, 28@30 deg., $2.05@$2.113 per bbl.; 18@22 deg., $2.075@$2.139; 13@16 deg., $1.78½@$1.848 per bbl.

Boston—July 14, tank-car lots, f.o.b heavy oil, 12@14 deg. Baumé, 4¾c. per gal., light oil, 28@32 deg. Baumé, 6¾c. per gal.

Cincinnati — July 21, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 4¾c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5⅝c. per gal.

Chicago—July 22, 20@22 deg., 5½c. per gal.; 24@26 deg., 6c. per gal.; 28@30 deg., 6½c. per gal.

New Plant Construction

Calif., Ahwahnee — Tri-County Tuberculosis Hospital, will purchase one 60 hp. standard horizontal tubular boiler with all equipment.

Calif., El Centro—The City Council, is having plans prepared for the construction of a pumping plant, including two 900 gal. and two 1,800 gal. electric driven pumps. Cost to exceed $100,000. Cone & Harris, 606 S. Hill St., Los Angeles, consulting engineers.

Calif., Friant—San Joaquin River Water Storage District, Madera, is having preliminary plans prepared for storage dam and power house on San Joaquin river near here, reservoir to store about 200,000 ac.ft. water and approximately 30,000 hp. to be developed at power plant. Estimated to cost $7,000,000. Distributing system will be constructed for irrigation of 550,000 acres. A. J. Wiley, consulting engineer, Boise, Idaho, and H. Barnes, Los Banos, resident engineer. Total estimated cost from $25,000,000 to $30,000,000.

Calif., Fullerton—The Sanitary Districts of La Habra and Buena Park had preliminary plans prepared for three alternative disposal systems including pumping plants. L. W. McCollum, Wickersheim Bldg., is engineer. Estimated to cost from $30,000 to $90,000.

Calif., Laguna Beach—Laguna Sanitary District is having plans prepared for complete sewer system, sewage disposal and pumping plant, cost to exceed $70,000. Black & Veatch, Fay Bldg., Los Angeles, is engineer.

Calif., Merced — Merced Irrigation District, R. V. Meikle, chief engineer, having plans prepared for power plant equipment for Exchequer Power House.

Calif., Red Bluff — Irrigation District, now being organized, is having plans prepared for irrigation project comprising about 35,000 acres, including dams, and individual pumping plants throughout the district. Estimated to cost $400,000. S. E. Kieffer, 57 Post St., San Francisco, consulting engineer.

Calif., Red Bluff—E. B. Perrin, c/o H. A. Kleugel, Balfour Bldg., San Francisco, engineer, is having plans prepared for power project on Thomas Creek, including power plant, to develop 27,000 hp.

Calif., Santa Ana — The City Council plans election to vote bonds for an electric power plant, estimated to cost $75,000.

Calif., Venice—The City will purchase centrifugal pumps with 2 G. E. motors, discharge pipes, etc., for proposed sewer system in Silver Strand Tract.

Col., Colorado Springs—The City is contemplating a new steam plant for its auxiliary to cost from $380,000 to $460,000, depending upon whether the plant will be of 2,500 kw. or 5,000 kw. F. P. Wood, of Wood & Weber, Denver, is engineer.

Conn., Bridgeport—The United Illuminating Co., are planning addition to their present 30,000 kw. Steel Point station, including boiler room, turbine room and switch house. Westcott & Mapes, Inc., New Haven, designing and supervising engineers.

Conn., Leesville — Central Connecticut Power & Light Co., 72 Main St., East Hampton, Conn., plans to build 80 ft. dam at Salmon River; also 1500 kw. high tension line from East Hampton to Glastonbury with side extension to Buckingham. Estimated to cost $250,000.

Conn., Wallingford—Masonic Home, c/o W. Arnold, 34 West Main St., Meriden, Archt., awarded a contract to C. F. Wooding Co., Wallace Ave., for hospital, power house and laundry buildings, estimated to cost $150,000.

Ill., Harvey—Whiting Corp., 155th Street, is having plans prepared and will take bids about Sept. 1st, for boiler house for machinery factory. Estimated cost $40,000. Chatter & Hammond, 160 North LaSalle St., Chicago, architects.

Ind., Anderson—Hughes-Curry Packing Co., 1800 West 8th St., has new plans prepared and will receive bids until Aug. 15th, for the construction of a 2 story packing plant, estimated to cost $100,000. Machinery for packing and refrigerating will be purchased.

Ky., Fords Ferry — Office of United States Engineer, P. O. Box 72, Louisville, will purchase one 15 kw. 110 v. d.c. steam driven direct connected generating set for dam No. 50, Ohio River.

Ky., Louisville—Office of United States Engineer, P. O. Box 72, will purchase two electric motors, a.c. 30 hp. 220 v., 60 cycle, 3 phase, 900 r.p.m. and three single phase transformers 25 kva. pole type; also one switch board 75 kw. for dam No. 49, Ohio River.

Md., Baltimore—The Board of Awards will receive bids until July 30th, for one 75 hp. motor and one centrifugal pump for Back River disposal plant. B. L. Crozier, highways engineer, City Hall.

Mass., Cambridge—Holy Ghost Hospital, Bridge St., awarded a contract to John F. Griffin Co., 15 Exchange St., Boston, for boiler plant and laundry building, cost to exceed $40,000. W. H. McGenty, 241 Adams St., Dorchester, is engineer.

Mass., Chelsea—Forbes Lithograph Mfg. Co., 80 Boylston St., Boston, awarded a contract to Aberthaw Co., 27 School St., for a power house here, estimated to cost $50,000. Monks & Johnson, 27 School St., Boston, architects.

Mass., Boston—Boston Elevated Railway Co., Park Square Bldg., has awarded a contract to Walsh Bros., 150 Hampshire St., Cambridge, for lobby building, including power house and garage. Cost $80,000. A. J. Blackburn, c/o owners, is engineer. This is the first unit of their $200,000 project.

Mass., Boston—The Metropolitan District Comn. plans to purchase two centrifugal impeller wheel pumps for Charlestown pumping station, estimated to cost $10,000. J. R. Rablin, 1 Ashburton Pl., is engineer.

Mass., Boston—The Morton C. Tuttle Co., 862 Park Square Bldg., has awarded a contract to Tileston & Hollingsworth Co., River St., Hyde Park, for the erection of a beater room and a rag boiler room. G. F. Hardy, 300 Broadway, New York, is engineer.

Mass., Springfield—Westinghouse Electric Co., Worthington St., awarded a contract to F. T. Ley, 495 Main St., for boiler house and heating plant, on St. James Ave., estimated to cost $250,000. McClintock & Craig, 33 Lyman St., is architect.

Mass., Winchendon — Mason & Parker Mfg. Co., will purchase electric generator, 75 to 100 kw., 220 v., 3 phase, 60 cycle.

Minn., Owatonna—Public Utilities Commission, M. R. Cashman, Chairman, awarded contracts for power plant building and equipment, also electric distribution to Donovan Construction Co., St. Paul, for $263,900. All bids for heating system were rejected. Arthur L. Mullergren, Kansas City, Mo., consulting engineer.

Miss., Boonsville—The City Council, will soon receive bids for distribution system, pumping equipment, etc., for waterworks estimated to cost $30,000. A. H. Beard, 616 Title Guaranty Bldg., St. Louis, Mo., is engineer.

Mo., St. Louis — Treasury Department, Supervising Architect's Office, Washington, D. C., will receive bids until Aug. 4th, for removing the present boilers, and furnishing and installing two new steel down draft, fire box type, high pressure boilers, arranged for portable setting at the U. S. Marine Hospital here. James A. Wetmore, Acting Supervising Architect.

Neb., Greenwood—The City Council, plans election to vote bonds for $20,000 for water works and distribution system. Grant, Fulton & Letton, 505 Bankers Life Bldg., Lincoln, is engineer.

N. Y., Binghamton—The Delaware Lackawanna & Western Railroad Co., awarded a contract to the F. D. Hyde Co., Inc., 90 West St. New York, for power house, etc. This is a part of the Conklin Ave. yard, estimated to cost $2,250,000.

N. Y., Elmira—The Elmira Water, Light & Railroad Co., has purchased site on East First St. and Railroad Ave., and plans power house and transformer station, estimated to cost $40,000.

N. Y., Sherrill—Kenwood Electric Light Co., c/o M. W. Keller, plans two steam electric power plants, one here and one at Vernon, estimated to cost $55,000.

N. Y., Troy—The Hudson Valley Coke & Products Corp. awarded a contract to The Foundation Co., 120 Liberty St., New York, for a byproduct coke plant, including an auxiliary water gas plant for making blue water gas for heating ovens and carburetor water gas for the supply of six Hudson Valley cities Total cost will be about $2,500,000. In connection with this contract, the Burden Iron Furnace is to be modernized under the supervision of The Foundation Co. at a cost of approximately $1,000,000.

Okla., Clinton—The City Council has called an election Aug. 9th to vote bonds for $80,000 for a dam and pump station, new pumps and mains. Bert M. Hart, City Hall, Oklahoma City, engineer.

Okla., Stillwater—The City Council will take bids in August for water works system, estimated to cost $250,000. V. V. Long & Co., Oklahoma City, engineers.

Okla., Texola—The City Council, plans to build light plant, water works and distribution system. Work will probably be done by day labor.

Pa., Philadelphia—Arguto Oilless Bearing Co., 149 West Berkley St., will soon award the contract for the construction of a power house. Owner will receive bids for heating, boiler, engine, lighting etc. Harris & Richards, Drexel Bldg., are architects.

Pa., Philadelphia—Kauffman Plush Co., Inc., Mitchell and Rector Sts., awarded a contract to P. Harbach, 1261 North 26th St., for a dye house and engine room, estimated to cost $40,000. Ballinger & Co., 12th and Chestnut Sts., Architects.

Tex., Austin—The City, W. D. Yett, Mayor, and C. N. Avery, Water & Light Commissioner will receive bids until about July 31st, for one 2 stage 2,800 G.P.M. centrifugal pump. 320 to 330 ft. head driven by 500 hp. synchronous motor; one 5,200 G.P.M. centrifugal pump, 50 ft. head, 100 hp. synchronous motor, one 3,900 G.P.M. centrifugal pump, 49 ft. head, 75 hp. squirrel cage motor; one 2,600 G.P.M. centrifugal pump, 49 ft. head, 50 hp. squirrel cage motor. All motors 2,300 volt, 3 phase, 60 cycle, G. E. Allis-Chalmers, Westinghouse or Crocker-Wheeler make. C. R. Leonard, city engineer, and J. B. Hawley, consulting engineer, 403 Cotton Exchange Bldg., Fort Worth, Tex.

Tex., Fort Worth—Arlington Ice Co., Arlington, is having plans prepared for a 100-ton ice plant on 5th Ave. and 4th St., here. Estimated to cost $100,000. Private plans.

Tex., Harlingen—The Alley Ice & Electric Co., plans addition to ice and electric plant, to double capacity, estimated to cost $100,000. Private plans. Additional machinery will be required.

Tex., Palacios—The City Council, c/o D. Ruchzen, plans the construction of a power and light plant, estimated to cost $50,000.

Wash., Aberdeen — The Grays Harbor Railway & Light Co. has applied to the State Supervisor of Hydraulics at Olympia for permit to appropriate 34,000 ft. on Queets River in Jefferson County, involving construction of power plant to cost approximately $1,000,000 to develop 10,000 hp. The company has also applied for water rights on the Hoh River in Jefferson County to construct a power plant with 25,000 hp. capacity, estimated to cost $3,200,000.

Wis., Racine—W. H. Pugh Coal Co., will purchase coal handling machinery, electrically operated.

Wis., St. Francis — Milwaukee Electric Railway & Light Co., Sycamore and Second Sts., Milwaukee, awarded a contract to Meredith Bros., Co., 253 Washington St., Milwaukee, for addition to turbine and switchboard room. Estimated to cost $50,000. F. Luber, c/o owner is architect.

N. S., Grand Etang—Dominion Fisheries, Ltd., will purchase equipment for cold storage plant.

Que., Hull—Ottawa River Power Co., Montreal, plans to build an auxiliary steam power plant and electric sub-station at Val Tetreau, estimated to cost $300,000. R. G. Gale, Hull, is engineer.

Ont., Leamington—The Common Council is having plans prepared for 12 in. pipe line to lake and installation of electrical pumping equipment. J. J. Newman, Davis Block, Windsor, is engineer. Estimated to cost $50,000. Prices wanted on materials and equipment.